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Innovation in a New Energy Landscape

How Radical Technology can increase Commercial Viability in the Oil and Gas Industry

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- How the Oil and Gas Industry can use radical technology to increase commercial viability

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Innovation in a New Energy Landscape: How Radical Technology can increase Commercial Viability in the Oil and Gas Industry

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Abstract

As the focus on reducing CO_2 emissions increases and the global demand of energy is rising, the oil and gas industry faces competition from other sources of energy. To take competitive advantage with competing energy suppliers, technology and innovation may be an important factor to ensure commercial viability for the oil and gas sector.

The thesis explores selection principles GE Oil and Gas use to consider innovation initiatives. In a qualitative, three embedded case I analyse institutional factors and innovation factors that affect the selection of innovation initiatives. Furthermore, I use interviews, observations and documents to understand how these selection principles can facilitate radical innovations solving the major challenges facing the oil and gas industry.

GE Oil and Gas is a supplier to the oil and gas industry and they collaborate with customers and stakeholders in the selection of innovation initiatives. GE Oil and Gas interact with customers and stakeholders on three levels of which they enjoy an informal relationship strongly affecting how they select innovation initiatives. Furthermore, the analysis implicates that formal institutional factors on all three levels strongly affect the potential to succeed with radical innovation initiatives at GE Oil and Gas. The analysis reveals that companies who fails to succeed with radical innovation initiatives at times where innovation factors are not the main challenge to innovation selection, can facilitate successful radical innovations by improving their formal selection principles. Improvement occurs by strengthening formal principles through the allocation of resources (time, personnel and money), removing time-consuming bottlenecks for innovation and setting the priorities to select and succeed with radical innovations. Finally, the thesis implicates that implementing these measures will enhance the unqiue position of GE Oil and Gas to develop radical technology solving some of the challenges facing the oil and gas industry.

Preface

This thesis concludes a two-year master program under the Centre for Technology, Innovation and Culture (TIC) at the University of Oslo. In collaboration with GE Oil and Gas, this thesis has conducted a one-year research project with a main objective to enhance knowledge on factors that drive decision making in the early phases of innovation and technology development in the oil and gas sector.

First of all, I would like to thank my supervisor at the University of Oslo, Morten Fosaas for his invaluable help, comments and advice during the work with my thesis. I would also like to thank Jarle Moss Hildrum for help with the research questions and structure. Secondly, I give a special thanks to Morten Wiencke, Lars Slagsvold, Arnar Kristjansson and Rune Strømquist at GE Oil and Gas for important contributions and insight to the oil and gas industry and for help with access to data material and informants. In addition, I would like to thank everyone at the GE Oil and Gas office who has contributed with knowledge, help and inspiration along the way. Finally, I am extremely grateful to all informants who shared their knowledge and perceptions of innovation in the oil and gas industry. I humbly take on full responsibility for any potential misinterpretations of data.

I would like to thank my fellow students at TIC for motivation and support - the last two years would not have been the same without all the fun we had together. The TIC Centre provided financial support enabling necessary data collection to complete the thesis in time, and for this, I am grateful.

My roommates, my parents and my sister deserve my humble gratitude – you have been exceptional and your kind words helped me finish in time. Finally yet importantly, I would like to express gratitude to my father Stephen Frank Loxley, Izabela Vang and Olav Schewe for editorials on contents and to Tor Bergersen who provided help with printing the issues.

Best Regards,

Ellen Loxley

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Abbreviations

BPM – Business Program Manager

GE – General Electric

GOT IA – Gas and Oil Technology Implementing Agreement

GRC – GE Global Research Center

IEA – International Energy Agency

IOC – International Oil Company

IP(R) – Intellectual Property (Rights)

JIP – Joint Industry Project

LNG – Liquid Natural Gas

NDA – Non Disclosure Agreement

NIH-syndrome – Not invented here Syndrome

NOC – National Oil Company

OEM – Original Equipment Manufacturer

PPM – Project Portfolio Management

PSA – Production Sharing Agreement

P&L's – Profit and Loss Centres

R&D – Research and Development

ROI – Return on Investment

TCA – Technology Collaboration Agreement

TRL – Technological Readiness Level

T-session – Technology session (Workshop)

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1 Introduction

Over the past decades, the literature within the field of innovation management (Reid and De Brentani, 2004: 1) and neo institutionalism (Powell and Colyvas, 2008) have provided tools to increase knowledge on how to manage the early phase of innovation. This master thesis aims to contribute to this theory by examining institutional factors and innovation challenges that affect innovation selection at GE Oil and Gas, a systems supplier and original equipment manufacturer (OEM) to the oil and gas industry. This thesis analyses institutional factors on three levels; intra-organizational[1], inter-organizational and macro institutional[2]. It aims to gain insight to how this company can develop selection principles to facilitate radical innovations[3]. Radical innovations emerge from technological breakthrough and can lead to the introduction of a new-to-the-world machinery (Verspagen, 2005: 493) (Edquist, 2005: 8).

Suppliers to the oil and gas industry are facing multiple challenges: Oil and gas reservoirs are located in particular harsh environments and in extremely remote parts of the world. In addition, oil and gas extraction is expanding to geographical areas experiencing high political instability subduing a potential risk for future return on investment (ROI) (Talseth, 2014). The new global context sets a strain on the industry to reduce costs while facing massive technical challenges to oil and gas exploration.

The global energy demand is expected to rise by more than 50% before 2030 (Birol, 2013) and competing sources of energy have a potential of becoming more important suppliers in the future energy landscape. Not only must the oil and gas industry develop technology which gains access to deeper and more remote oil and gas reservoirs, but there is a demand for sustainable technology reducing greenhouse gas emissions during exploration of oil and gas (Ministry of Petroleum and Energy, No date). Consequently, global warming is becoming a vast challenge that the industry has to cope with in order to continue as a global energy supplier in the future energy landscape (Ministry of Climate and Environment, 2011-2012). It is a global problem, whereas existing emissions are claimed to derive from industrialized countries and future emissions are expected to emanate from developing countries and emerging economies. In the new energy landscape, OEM's may increase their presence in developing countries and

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[1] Or company level.
[2] Or governmental level.
[3] See the definition of radical innovations in chapter 2.1 for more information.

emerging economies where institutional factors are seen as severe and unpredictable (Miller and Lessard, 2000: 82) (PETROPOL, 2006: 6)

Companies take on innovation to achieve commercial growth and the prospect of ROI (Nelson and Winter, 1982), but this thesis emphasizes that challenges to innovation selection cannot be overcome by purely looking at economic variables (Reid and De Brentani, 2004: 1). This thesis examines how institutional factors affect innovation selection, and how this knowledge can counter the selection of less profitable innovation initiatives. Furthermore, it analyses how an increased number of radical innovations can be facilitated. Radical technology and innovation offer possible solutions to solve some of the challenges facing the oil and gas industry (Wiencke, 2014).

The oil and gas industry is facing a changing energy landscape[4] where radical innovations may determine which organizations that will enter the new landscape and which will be locked out. Therefore, the researcher raise the following research questions:

1. What affects the selection of innovation initiatives at GE Oil and Gas, and how can these selection principles facilitate radical innovations?

Proposition: Institutional factors will strongly affect the selection of innovations in GE Oil and Gas

2. How can GE Oil and Gas increase the potential to succeed with radical innovations?

1.1 Introduction to GE

The history of General Electric Company goes back to 1876, when Thomas Edison opened a laboratory in Menlo Park, New Jersey. From his laboratory, Thomas Edison developed the first glowing electric light bulb - a radical innovation as the first of its kind (General Electric, 2014: b). During the same period, another electrical innovation company led by Charles Coffin emerged as a vast competitor to Thomas Edison's newly established company. The two companies merged into The General Electric Company (GE) in 1892 and pursued to follow the former success criteria of both companies: The acquisition of promising technology companies

[4] In the new landscape, technology development has taken a new direction in terms of design, solutions and problems. The paradigm is dominated by the mind-set of leading scientists (Verspagen 2005: 497).

based on Coffins expertise, and the introduction of radical innovations provided by Edison's personal skills and characteristics (General Electric, 2014: a). Both criteria has been distinguishing features to describe GE's growth and corporate development into the current organization with 300.000 employees operating in more than 140 countries worldwide GE's current organization structure with nine business units as presented in the appendix was introduced in 2012 (General Electric, 2014: c). It involved restructuring the old business unit "GE Energy" into three distinct business units: Oil & Gas, Power & Water and Energy Management. The reorganization was needed to simplify communication of GE as one single entity towards customers, stakeholders and the public (Offshore Wind, 2012). In the organization chart, GE Global Research (GRC) is shown as a staff unit on corporate level, serving all business units. Since the early days, developing new technology for industrial purposes has been a priority for GE, and the company opened its own internal research facility in 1900. Today, GE has seven internal research facilities that have introduced a number of radical innovations substantially changing business (Albeniz, 2013).

The oil and gas business unit to GE is a recent development starting with the acquisition of the Italian company Nuovo Pignone that manufactures turbines and compressors in 1994. GE's transition to a full scale Oil and Gas equipment supplier continued in 2007 when it acquired Vetco Gray, a drilling and subsea equipment. In the following years of 2010-2013, GE acquired several companies emerging into a full-scale supplier of advanced technical equipment to oil and gas companies (Kranz, 2013).

1.2 Composition of the thesis

Literature from innovation management aims to present why companies should select radical innovations, it presents challenges to facilitate radical innovations and suggestions to how companies can select radical innovations. Furthermore, the reader is introduced to the theoretical proposition that institutional factors, formal and informal, on three levels can affect how companies select innovations and how these factors may affect future ROI if the company succeeds in executing them.

The methodology chapter provides detailed and informative reflections of research design, research techniques and the researcher's personal experiences from data collection enhancing the quality of the thesis. In chapter 5-8, the three embedded case studies are contextualized, described and analysed. Each section ends with a summary presenting main implications from the analysis. The final chapter summarizes main findings and redeems answers to the research questions. In addition, the to implications for further research.

2 Concepts

Chapter two defines and explains innovation and institutional factors. They are key concepts to understand the research questions and the strands of literature this thesis aims to contribute. The explanation emphasizes how each concept can be analysed in a qualitative case study.

2.1 Innovation

Innovation can be defined as a new product, the exploitation of new markets, new service or a new production process (Edquist, 2005: 6-7) which is operationalized through a technological development project. Innovation can be divided into radical and incremental classified from the type of technology applied to develop the project. Although incremental technology is considered as crucial for commercial growth (Fagerberg, 2005),this thesis focuses upon radical innovations and therefore emphasizes to elaborate this concept. Still, incremental technology will be defined to shed light on how the two types of innovation differ.

2.2 How radical and incremental innovation differ

Incremental innovation is activity close to the core competence and knowledge base of the organization in question (Nagji and Tuff, 2012: 68), and exploits internal knowledge to develop new solutions by utilizing existing and familiar technology (Levinthal and March, 1981) (Garcia and Calantone, 2002: 125- 126). Incremental innovation is normally recognized in the form of continuous development, often resulting in product refinements on a day-to-day basis. While these refinements have a tremendous impact on the productivity of the organization, underlining their importance, one refinement does not have a dramatic effect on the society as a whole (Freeman and Perez 1988: 45-46). This is an important difference between incremental and radical innovations.

Radical innovations are defined as “new to the world solutions” (Nagji and Tuff 2012: 68) and therefore have a potential of influencing the infrastructure in the geographical area where they are introduced. The term radical in this context refers to how radical the innovation is compared to current technology (Fagerberg 2005: 7), and consists of activities designed to create completely new products, processes or services, or to serve new markets and customer needs (Freeman and Perez 1988: 45-46). Furthermore, radical technology offers new benefits to customers and differs substantially from the existing technology path a company or an industry is following (Chandy and Tellis, 1998). Company collaboration or inter-company learning can therefore be crucial for developing successful radical innovations because it opens for external knowledge flows (Bao et al., 2012: 1230). In a supplier-customer relationship, radical innovations are more likely to emerge from intimate and prolonged interaction between collaboration partners (Powell and Grodal, 2005: 65).

Radical innovations appear to be a broad concept with many characteristics. The following section intends to create a division of radical innovations into two types of projects, and then describe how they distinguish from one another.

2.2.1 Radical innovations in the current technological landscape

The customers usually requests radical innovations within the current technological landscape because they are familiar with the products and current technology. Consequently, this is referred to as market pull since it is easier for them to identify their problem and express their preferences (Tidd and Bessant, 2009: 390). The introduction of the innovation itself can cause significant changes to how the oil and gas industry conduct business. The innovation, however, does not involve a new market infrastructure. These innovations are "big bets" or key strategic commitments with a longer investment perspective than incremental innovations (Tidd and Bessant 2009: 326). These types of innovation projects are of relevance for drilling in deep waters and gaining access to reservoirs in a harsher climate, like the Arctic for instance. Finally, the innovation would be the first of its kind and completely new to the market in question (Garcia and Calantone, 2002: 123)

2.2.2 Radical innovation in a new technological landscape

Radical innovation in a new technological landscape differs in substantial areas from radical innovations in the current technological landscape. This type of radical innovation projects embodies a new technology that results in a new market infrastructure. The innovation project does not address a recognized demand but instead creates a demand unknown to the customer (Garcia and Calatone 2002: 120-121). There are many needs that the customer may be unaware of, and in these circumstances, the balance shifts to a technology-push strategy (Tidd and Bessant 2009). For instance on a customer collaboration project, if the supplier suggests development of a radical innovation projects consisting of technology from another sector, this could qualify as a radical innovation in a new technological landscape. Besides technological capabilities, when a radical innovation project is introduced into the market it usually require a new set of organizational capabilities (Garcia and Calantone 2002). To facilitate and increase the potential to succeed with these innovation initatives, working with stakeholders or customers can be paramount to reduce risk and to ensure future ROI (Tidd and Bessant 2009: 327-330).

2.3 Institutional factors

In this framework, an institution consist of formal and informal structures and activities that provide stability and meaning to social behavior. Institutions operate at multiple levels of jurisdiction (Scott, 2004: 8). Edquist defines institutions as the rules of the game (Edquist, 2005: 182), and they are essential to regulate the relations and interactions that arise from collaboration. Institutional factors can be a formal regulatory structure or a routine constructed by the state or the empowered entity in question. Also, an institutional factor can be an informal normative structure (Scott 2004: 8) laid down by the values or the moral commitments within an intra-organizational, inter-organizational or governmental level of society (Strang and Sine, 2002: 4). Therefore, a formal institutional factor is defined in this paper as a written rule that regulates the formal and informal relation and interaction between organizations, actors or individuals. An informal institutional factor is a norm regulating how people behave and is not written down in text.

A formal institutional factor can be understood as an institution of law and bureaucracy (March and Olsen, 1984: 734), and will be measured as explicit knowledge codified as written text in paper, document or in a database. An informal institutional factor can be understood in terms of informal ties between individuals, among corporations or amongst governmental entities. These ties arises when individuals, organizations or governments direct flows of information and resources within a social structure (Scott 2004). They will be measured through perceptions that individuals express in interviews or under observations. Institutions are subject to individual interpretations, and one may encounter that employees, companies or governments practice institutional factors differently.

3 Theoretical Framework

The theoretical chapter presents major challenges to innovation selection based on literature from innovation management. Innovation selection can be problematic and associated to high risk. Therefore, the chapter describes selection principles utilized by commercial companies to facilitate radical innovations. Then, the chapter will introduce theory that underscores how institutional factors on three levels can counter the major innovation challenges and why a company should select radical innovations. The chapter aims to outline a framework explaining how a company can enable the selection of radical innovation initatives and increase their potential to succeed.

3.1 Historical background to innovation selection

The academic history of innovation selection goes back to the linear model of innovation introduced by Vannevar Bush in 1945. His understanding of how science and technology had an impact on the economy became the most influential theoretical framework to understand innovation and technology development. His model explained innovation in four steps:
Basic research → Applied research → Development → (Production and) Diffusion (Godin, 2006: 639).

The “Innovation Funnel” (the Funnel) presented in Figure 1 separates the innovation process into phases. The first phase begins with the search of new ideas and it moves across four phases and into the execution phase where the innovation is introduced into the market (Tidd and Bodley, 2002). Innovation selection concerns the second phase of the Funnel.

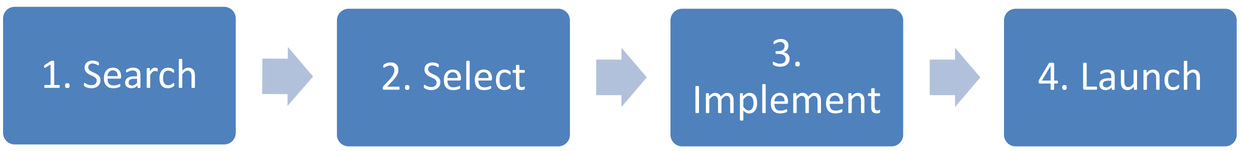

Figure 1: Innovation Funnel (Tidd and Bessant 2009: 64).

Traditionally, innovation was described as a closed process where successful innovation implied complete control of how the innovation initiatives came into life, who participated in the process and what kind of outcome that was desirable. Companies performed all steps in the linear process themselves with innovation starting at their in-house research facility (Powell et al., 1996: 1). Inevitably, all steps of the selection process were performed within the internal environment of the organization, making it easy to control and to measure through formal rules. At the time, large research-based companies did most of the research in their respective industries, and they were successful earning most of the profits (Chesbrough, 2003: xvii-xv). Successful innovations were measured in terms of ROI, and innovation projects that never reached the market, or failed after being introduced into the market, were never really looked into. The closed model of innovation worked well during the 20th century. Commercial companies from a wide range of sectors, including telecommunications, microelectronics, weapons and biotechnology, introduced several radical innovations solving major social problems in the market (Freeman and Perez 1988: 54-57).

By the end of the 20th century, radical innovations made it easier, faster and less costly to interact across boundaries, to share competency and to absorb knowledge external to the organization. Large companies were challenged by smaller start-ups with external R&D facilities and a new imperative emerged: Innovate or die. Innovation was no longer an internal phenomenon, and if the successful companies of the 20th century wanted to maintain technological superiority and commercial viability, they would have to reorganize, cut costs on innovation and absorb knowledge outside the established path of the organization. The reorganization involved external collaboration and knowledge flows affecting innovation selection directly (Powell et al., 1996). This required a new set of formal rules to deal with challenges to innovation selection that the closed model of innovation was unable to handle (Chesbrough, 2006)[5]. The old established technology leaders imposed new initiatives to catch up with competitors introducing solutions that made their technology obsolete.

The classic example of the 20th century was Xerox, a high-tech company focusing on high-speed copy machines and printers. At their internal research center, scientists and engineers developed several new solutions built on radical technologies. Innovation initiatives like the mouse and the user interface for PC were terminated because they were not compatible with the business of copy machines and printers (Isaksen and Tidd 2006: 55) . At the time, newly established companies like Apple and Microsoft based their own products on the

[5] The new methods and rules are introduced in chapter 3.2

technology developed at the Xerox research center. Consequently, Apple and Microsoft earned tremendous commercial benefits (Chesbrough, 2006: 130). In this case, Xerox had been exposed to path dependency.

3.1.1 Innovation challenges to innovation selection

In a path dependent company, technology change transpires from a history of technology development over a longer period of time (Mokyr, 1990: 163). Path dependency would also apply for institutions and policies within the company (North, 1990) (Pierson, 2000) .Institutions can help companies avoid the challenges arising from path dependency. Formal and informal ties can encourage companies to avoid being stuck to a particular technology path and remain open to different and competing ideas in the early phases of technology development (Fagerberg 2005: 10).

The old technology leaders of the 20th century, for instance, enjoyed progress from the path following the closed model of innovation (Mokyr, 1990: 163). By following a technology path, the companies were locked into the same “path” through different reinforcing effects. When a company is locked into a technology path, it has suffered from a lock-in effect. When alternative and superior technology paths emerged companies could be locked out from these when it has become too costly or too late to switch paths (Fagerberg 2005: 10). When companies are barred to develop technologies, or their technology is rejected by the market they have they sufferied from a lockout effect (Schilling, 1998). Lock-in and lockout are effects from path-dependency.

It has been claimed that the oil and gas industry is a conservative sector where market conditions change slowly, and consequently the introduction of radical innovations is difficult (Von Tunzelmann and Acha, 2005: 409). Therefore, this is an industry particularly exposed to path dependency. Another innovation challenge that appears across the main contributions to the innovation literature is inertia, or resistance to change, as Schumpeter (1947) describes it. Inertia is a part of every individual, the company and the society, and it makes it very difficult to succeed with innovation initiatives. Inertia also applies to the implementation of new ways of managing innovation. Fagerberg (2005) emphasizes that inertia can be overcome by establishing institutions that secures variety within the system. Variety can be secured through rewards and by steps that reduce uncertainty of the future outcome of the innovation (Fagerberg, 2003: 152).

Another major challenge that may occur is the “not-invented-here syndrome” (NIH-syndrome). The NIH-syndrome becomes evident when the rejected innovative idea originates from an environment external to the organization or the individual. If the rejection happens because the idea is seen as too distant from the core knowledge base of the organization, the organization risks being locked-out from different technology paths (Cohen and Levinthal, 1990: 137). Therefore NIH-syndrome, and in turn the lockout effect, can be a vast challenge to make optimal decisions in the screening of innovation projects.

The literature indicates that path dependency, inertia and NIH-syndrome interrelates. Furthermore, it can be assumed that a company subject to one of these challenges could easily experience the other challenges and risk being locked out from radical ideas that competitors may catch up on. The theory points to the relationship between institutions and these challenges as intertwined.

3.2 Management tools for innovation

Many selection principles are described in the literature to help companies improve their selection initiatives. This section aims to explain three of the most popular approaches; Open Innovation, the Stage-Gate System and the Innovation Funnel. This is important to understand how companies use selection principles to identify viable innovation initiatives with a high potential to succeed.

3.2.1 Open Innovation

Recently, companies have reorganized their business models to collaborate with stakeholders and customers on their innovation projects. Defined by Chesbrough et al. (2006), the “*open innovation model is the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation respectively*”. Open innovation assumes that organizations can and should use external ideas as well as internal ideas to search, screen and initially select innovative ideas (Chesbrough et al., 2006: 1). A major difference of open innovation compared to its antecedent, the closed model of innovation, lies in how organizations screen their ideas. In any R&D process, researchers and their managers must separate poor proposals from the good ones so they can discard the former while pursuing commercialization of the latter. Both models are adept at weeding out “false positives” (bad ideas that initially look promising), but open innovation also incorporates the ability to rescue “false negatives” (projects that initially seem to lack promise but turn out to be seemingly valuable) (Chesbrough et al., 2006: 130). Through exposure to external knowledge, companies may counteract path dependency in the selection of innovations and gain innovation initiatives with a higher potential to succeed.

3.2.2 Stage-Gate System

The Stage-Gate system leaves little room for flexibility and is often used as a roadmap for large innovation projects in manufacturing companies. It is similar to the Funnel in the sense that projects are filtered according to business opportunities during the development process (Tidd and Bessant 2009: 315). The Stage-Gate system works well as a control system with innovation occurring through a number of stages where different decision criteria must be passed. The overall objective is to ensure a review of technical and marketing data at a number of stages throughout the innovation process (Tidd and Bessant 2009: 388). The system is a stringent tool leaving little room for flexibility and can be well suited for incremental innovations (Tidd and Bessant 2009: 314-315). The Funnel is better suited to manage radical innovations since they are difficult to formalize into a strict linear process (Godin 2006). It is more flexible and less stringent than the Stage-Gate system. In addition, the Funnel has the ability to reconsider innovation commitment throughout the process, emphasizing that some projects may turn out to be too risky or too costly to complete (Tidd and Bessant 2009: 315). This is crucial because some successful radical innovations appears as a spin-off from the initial innovation project, or from an informal setting that is difficult to manage with a Stage-Gate system (Tidd and Bessant 2009: 314). Consequently, a Stage-Gate system seems to be too simple and stringent for organizations aiming to develop successful radical innovations.

3.2.3 Innovation Funnel

In each phase of the Funnel presented in Figure 1, the risk related of failing with innovations is reduced (Tidd and Bodley, 2002). The idea is to increase the commitment to innovation projects over time and to make stepwise decisions on where to allocate scarce resources (Tidd and Bessant, 2009: 312 - 313). When conducting commercial analysis considering resource constraints, understanding the allocation of scarce resources is essential (Tidd and Bodley

2002). Central to this process is knowledge to reduce risk in the early phases where uncertainty related to innovation selection is high, and this knowledge is gathered by conducting R&D, market research, competitor analysis and trend spotting (Tidd and Bessant 2009: 312).

The Funnel can be useful as a roadmap providing the decision maker with some guidance in a complex environment of decision-making. At the same time, it has the flexibility to include diverse knowledge and enable access to unlimited sources of information in the early stages of the innovation process. By opening up for a variety of knowledge flows, one can reduce many challenges to innovation selection and this is crucial since it opens up for allocating resources to viable innovation initiatives later on. Given the high risk associated to radical innovation projects, this can be essential to increase the success rate. Finally, there is need for some formal features and strategic management of the selection process (Tidd and Bessant 2009: 342) and the next section will outline formal and informal rules from the theory of neo-institutionalism affecting how companies perform innovation.

3.3 Neo institutionalism

Institutionalism can be used to analyse innovation selection because it seeks to address why and how organizations behave in a certain manner and describes the relationship between an organization and its environment (Greenwood et al., 2008: 28). Institutional factors only exist if they affect behavior, and once an institution is established, formal or informal, it takes time to change it (Powell and Colyvas, 2008).This thesis will present three levels of institutional literature proven to affect organizational behavior. This is essential to redeem answers for the proposition that institutional factors affects innovation selection strongly.

3.3.1 Macro level institutional factors

Powell and DiMaggio united the different strands of institutionalism within organizational analysis into a one theory, neo-institutionalism (Powell and DiMaggio, 1991). Institutionalism opens up for a multidimensional analysis of the organization. Macro level institutionalism emphasizes the importance of legal and political conditions supporting technology development. Local, national or international governments typically draw legal and political conditions, policies or formal laws, which defines the regulatory framework of a geographical area. This legal framework can give benefits to certain companies and turn out to be a disadvantage for others (Hwang and Powell, 2005: 182).

Occasionally macro level institutional factors may change abruptly and have the potential of affecting innovation initiatives strongly. This often occurs when groups seize unexpected opportunities, for instance after an election, a coup or a civil war (Hwang and Powell 2005: 182). Legal or political conditions can change and companies will have to comply with a new set of laws and regulations (Hwang and Powell 2005). Institutions on a macro level present a higher challenge when companies select innovations for unstable markets with unpredictable institutional factors. Suppliers to the oil and gas industry often develop and deliver new technology for application in large engineering projects managed by oil and gas companies. These innovation projects involve permanent commitments, uneven allocation of profits and high probabilities of failure (Miller and Lessard, 2001: 2). Therefore, if political and legal conditions change often and are unpredictable, companies run a higher risk of missing ROI on innovations. The literature refers to unstable and unpredictable political and legal conditions as institutional risks (Lessard and Miller, 2001). To be clear: Institutional risks refer to risks that institutional factors have on future ROI for innovation projects.

Institutional risks can be reduced through compliance. Compliance programs are the internal programs and policy decisions made by a company in order to meet the standards set by government laws and regulations (Investopedia, 2014). Managing compliance is important for companies operating in the natural resource industry since they have been granted a licence to manage the non-renewable commodities of a country. Many companies emphasize that acting in accordance with local laws and regulations is important to reduce risk when innovations are introduced into a new area (EY, 2012). Secondly, authorities or standardization committees can lay down technical standards for a specific industrial sector. Companies may decide to innovate or to develop new technology to meet the public requirements laid down by technical standards. In many circumstances, standards are voluntary, but they affect how companies behave (Hwang and Powell, 2005: 182). Third, informal institutional factors on a macro level usually involve activities where companies engage in forums to discuss formal agreements with governments or NGO's[6] to build a common practice. Forum and informal discussions may establish norms or a practice to how companies should innovate. The latter is an example of a formal institutional factor on a macro level (Hwang and Powell, 2005: 191).

[6] NGO is an abbreviation for Non Governmental Organization.

Lessard and Miller (2001) emphasize that laws governing ROI, property rights or intellectual property rights (IPR), and contracts highly influence the success or failure of innovation projects. Poorly enforced political and legal conditions can lead to corruption. According to (Jain, 2001: 72),corruption seems to affect the willingness companies have to invest in a country. Also, Jain suggests that corruption affects the incentives governments adopts for innovation. In addition, corruption affects how laws and regulations are implemented. Innovations developed at OEM's may be intended for countries with high levels of corruption or unstable local conditions. Both have the potential of affecting the success or a failure of an innovation.

Governments can establish legal or political conditions leading to inequality or poor socioeconomic conditions for the local population. Companies who enter such markets with innovation projects may encounter resistance from local groups, economic-development agencies, and influential pressure groups (Miller and Lessard, 2001).These challenges can be countered through communication or by creating local content. Local content can describe the range of benefits the oil and gas industry can bring to the areas where it operates (Olsen, 2014).

3.3.2 Inter-organizational institutional factors

Nearly all organizations execute innovation through some form of inter-organizational collaboration (Powell et al., 1996: 116). Formal institutional factors regulate this type of collaboration through contracts. Inter-organizational factors become increasingly evident when they are hindering effective innovation collaboration. A lack of trust between the parties, difficulties in relinquishing control, the complexity of a joint project, and variance in the ability to learn new skills, are all informal factors that are affecting inter-organizational collaboration (Powell et al., 1996).

Companies are motivated to engage in inter-organizational innovation collaboration to acquire resources and skills they cannot produce themselves as long as the hazards of cooperation can be held to a tolerable level. Inter-organizational collaboration in the selection of innovation initiatives can appear from a motivation to access new knowledge to catch up with competitors or gain competitive advantage. Furthermore, companies decide to collaborate on innovation projects to reduce the risk of failure. A formal agreement usually leads to a number of informal collaboration ties (Powell et al., 1996). Companies may engage in inter-organizational collaboration to meet requirements laid down by entities of power on a macro level or on an intra-organizational level, for instance requirements to a technical standard. The common practice for companies to meet these requirements is to certify the technology by an independent body, typically another company. The certificate in itself is a formal institutional factor, but the norm to adhere to a voluntary standard is informal (Powell et al., 1996). Finally informal institutional factors on an inter-organizational level can involve activities like forums to discuss formal agreements where companies can engage in building a common practice, or in turn a formal institutional factor. Forums are also common on a macro level where governments and NGO's are attending (Hwang and Powell, 2005: 191).

3.3.3 Intra-organizational institutional factors

On an intra-organizational level, institutional factors can be formal rules passed by the management or the manager, and implemented into the organization as clear routines, goals or rules affecting how employees behave. Institutional factors on this level can be informal, for an instance norms or taken-for-granted beliefs within the organization (Powell and DiMaggio, 1991: 27 - 28). Intra-organizational factors are reproduced and asserted significance when employees engage in their practical everyday work, solve problems and derive answers to these problems based on routines or guidelines. From these actions, employees develop a working logic, and they make deliberate choices to comply with one logic and resist another. Consequently, institutional factors on this level can be the principles companies use to select innovation initiatives. In addition, it can be a contributing factor to why the individuals choose to select one innovation initiative and resist the other. Also, social interaction between members of an organization, or how members of an organization communicate, is a type of informal factor tying members together (Powell and Colyvas, 2008: 279).

Intra-organizational institutional factors are directly linked to performance because norms and formal rules within the organization directly affect how employees behave. How employees behave is emphasized as a vital factor to innovation, since intra organizational collaboration is an integral part of succeeding with innovations. Superior performance, however, can be achieved if these institutional factors can adapt to changes in environmental conditions (Rose, Naresh et al. 2008: 47). Different environmental conditions may include demands from customers and stakeholders or different political or local conditions in a market. Intra-organizational factors can be influenced by changing external environmental conditions (Acemoglu et al., 2012: 63). Therefore, companies should develop institutional factors that can adapt to external changes or different external market conditions but at the same time provide efficient internal integration of these changes (Chatman et al., 2013: 16).

For an institutional factor to be influential, members of the company must share a common set of expectations about appropriate or inappropriate attitudes and behaviors. These attitudes and behaviors must, in turn, be consistently aligned and reinforced across divisions and management levels (Chatman et al., 2013: 12). Organizational norms that facilitate flexibility and experimentation within the company can enhance organizational innovation and adaptation (Kotter and Heskett: 1992). Another intra-organizational institutional factor emphasized in the literature is educated employees trained with professional knowledge, who also possess knowledge of organizational jurisdiction. These individuals are often found in positions with the ability to change intra-organizational institutional factors. They have the authority to reshape the informal or formal ties, particularly with respect to definitions of the law. Similarly, occupational groups and technical professionals engage in the creation of standards. When these technical procedures are widely diffused, the existing set of organizational practices regarding innovation selection can be altered in subtle or profound ways (Hwang and Powell 2005).

This section has introduced institutional factors on all three levels, formal and informal, that affects how companies manage the selection of innovation initiatives. Knowledge of institutional factors can facilitate the selection of radical innovation initatives, and the remaining part of this chapter will introduce how a company should select radial innovations.

3.4 Managing the innovation portfolio

The thesis argues that the oil and gas industry can use radical innovations based on technology from a competing path to cut costs and reduce greenhouse gas emissions, these being major challenges facing the industry. In this respect, this section will argue why a company should use selection principles to facilitate radical innovations. According to Nagji and Tuff (2012), companies should allocate their resources with 70% to incremental innovations, 20% to radical innovations within the current technology path and 10% to radical innovations from a competing technology path. This resource allocation has to be adjusted to how companies performs commercially. For high performing companies[7], the distribution of return is 70 % on radical innovations based on radical technology from a competing path, 20% on radical innovations within the same technology path and 10 % on incremental innovations (Nagji and Tuff 2012: 70). Targeting a balanced innovation portfolio is difficult and only a few companies have the competency to develop such a broad range of innovations. A poorly managed portfolio means wasted time and a waste of resources leading the company into commercial decline (Ibid). Obtaining a balanced portfolio entails the allocation of resources in a sound manner ensuring good ROI, and this is essential if the organization wants to expand, increase revenue and prolong commercial viability (Cooper et al., 2001: a: 74).

In a mature industry like the natural resource industry where change happens slowly, Project Portfolio Management (PPM) can counter innovation selection challenges by enhancing variety over uniformity. PPM manages risk by diversifying resources and ensuring a balance in innovations entering formal development. In this respect, PPM can be a selection principle to evaluate new projects, select and prioritize projects, in addition to allocate and reallocate resources between the selected projects (Cooper and Kleinschmidt, 2007: 4). PPM use several factors besides the traditional economic variables to estimate the success of innovation projects (Tidd and Bessant 2009: 341). The most common indicators used to manage innovation portfolios have traditionally been financial criteria. These methods rate the projects according to a financial estimate. The problem with these methods, however, is that before a project is established, projections of ROI are speculative due to high risk. They are more appropriate for evaluating a single project and is therefore not described further on as a measurement technique for innovation portfolio management (Tidd and Bodley 2002: 130-131).

PPM can be utilized efficiently if the company is able to select innovations that constitute a balanced portfolio with a mix of projects that are incremental and radical. Furthermore, PPM decreases the potential of selecting low value projects since the selection decision follows a number of effective selection principles on how to allocate resources subject to proper consideration beforehand. In addition, risk of missing ROI is reduced since portfolio management ensures that resources are allocated according to long term and short term goals. Recently, pressure has increased for companies to select or terminate innovation initiatives faster, thus having a tool in the early phases (Cooper et al., 2000: 5 - 10) can turn out to be an advantage. Companies can choose to build a to business case to provide a pathway for radical

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[7] Nagji and Tuff describes high performing company as a company with a leadership position in its industry. These companies may want to diversify their investments between type of innovation to reduce risk (Nagji and Tuff 2012: 70).

ideas in the early phases of innovation. This can essentially be a “parallel” funnel to regular innovation development allowing a portfolio with higher risk ideas and options (Tidd and Bessant 2009: 332). Rapid prototyping and fast-works are tools to help the decision maker to make the right decisions based on physical representations and data simulations of form and substance (Tidd and Bessant 2009: 317) (Ries, 2011).

After the selection, a number of difficulties may occur in the implementation of the project itself. At the same time, the selected innovation projects should be in line with corporate strategy (Cooper et al., 2001: 8). Another challenge pointed out by Cooper (2001), appears through the selection of too many innovations, resulting in the organization being unable to develop ideas properly. Furthermore, a portfolio with a broad strategic scope can give organizations multiple opportunities to pull their resources and technologies across various markets (Grewal et al., 2008: 263). Portfolio methods try to deal with the issue of reviewing across a set of projects and work out a balance of economic and non-financial risk or reward factors (Tidd and Bessant 319). The goal is to enable predictions if an innovation initiative will lead to success or failure. It is crucial to evaluate across the entire portfolio of projects, even when decisions are being made for a single project only (McNally et al., 2013: 247). In fierce competition with competing companies in globalized markets and increasing demands from customers, the knowledge of gaining an in-depth understanding on how to allocate the resources of the company is essential (Cooper 2007: 3). The main benefit of portfolio management is how it considers several innovations in the attempt to maximize return.

On the one hand, a challenge with portfolio management is how it reinforces conflicting interests within a company and this can enhance difficulties to find a consistent and unified selection strategy. However, this flexibility is why it can be applied to a selection model which utilizes institutional variables since it can be adjusted to represent multiple disciplines (Cooper et al., 2001: a: 2- 4). On the other hand, the purpose of portfolio management is to provide a coherent basis to evaluate or to decide on which projects to be undertaken, and to ensure a good balance across the portfolio of risk and potential reward (Tidd and Bessant 2009: 216). In practice, this can work by regular scheduled reviews of all projects to ensure alignment with the company strategy.

3.5 How to facilitate radical innovations

An organization who has introduced a number of these innovations is Pentagon's Defence Advanced Research Projects Agency (DARPA), a tiny organization with a relatively modest budget developing a number of innovations upsetting the current technological trajectory, for instance the internet. They attract talented employees who are very skilled in collaboration. The project managers who initiate the selection decision usually have a master's degree and ten years of working experience. They have the personal attributes of successful CEO's in the industry. Their selection procedure consists of individual projects with fast iterations subsequently terminated or selected of the project leader. In spite of high uncertainty, DARPA has managed to create internal routines and an organization with an intense culture of adaptability. They have managed this by hiring temporary teams of personnel with diverse backgrounds working well together on each separate innovation project (Dugan and Gabriel, 2013). DARPA has introduced several revolutionizing solutions like the ethernet

3.6 Summary

The chapter has provided a theoretical framework to increase knowledge on the challenges companies may encounter in the selection of innovations. Early phase innovation has changed from a strict internal process into open innovation with external partners where external knowledgeflows and collaboration efforts have become increasingly important. Increasing knowledge on how institutional factors, formal and informal, affect the selection of innovations can provide more insights reducing the risk of failure. Radical innovations can be a solution to solve some of the major challenges facing the oil and gas industry and this chapter has introduced a theoretical framework encompassing knowledge and routines to facilitate radical innovation initiatives.

4 Methodology Chapter

This chapter will justify the choice of case as research design, choice of research object and the chosen research techniques. The researcher will clarify methods to maintain well-documented and well-founded procedures for data collection and data analysis. The chapter concludes with reflections regarding limitations of research strategy, validity, reliability and ethical concerns.

4.1 Justification of choice of case as methodical approach

This case study examines selection principles GE Oil and Gas use to select innovation initiatives. The thesis is based on the assumption that innovation selection in a large commercial company is affected by institutional factors and that the selection of radical innovations is very challenging. I chose to limit the scope to the facilitation of radical innovation projects because the vast majority of all new product introductions at GE Oil and Gas are incremental according to several informants. Therefore, this case study can be defined as a critical study, aiming to critically test theoretical components on an area with little previous social science research. Consequently, the researcher has been given access to the unusual case (Yin, 2014: 52). In addition, because none of the three case studies have been subject for social science research before, the researcher has been given access to the revelatory case study. The results can contribute to an increased understanding that may confirm, challenge or extend the theory related to innovation management (Yin, 2014: 50 - 52). The three embedded case studies have been chosen to show the variance of innovation initiatives this company (George and Bennett, 2005: 85).

Following the definition from Punch (2005: 12),qualitative research is defined as collecting written data of empirical information about social behavior not presented numerically. The general objective of a case study is to study one single case in detail and to develop a thorough understanding of that case using any appropriate research methods (Punch 2005: 144). The research questions have required a thorough and diverse in-depth investigation of social behavior at GE. Consequently, it has been chosen to conduct a qualitative case study. Qualitative research is usually performed through interviews, observations or document analysis (Winchester and Rofe, 2010: 8). All three techniques have been used to collect data in this thesis, in addition to a qualitative internet survey. Furthermore, the semi-structured interview has been the primary source of retrieving data on how informants, employees at GE or their stakeholders, perceive technology development in the oil and gas industry (Punch, 2005).

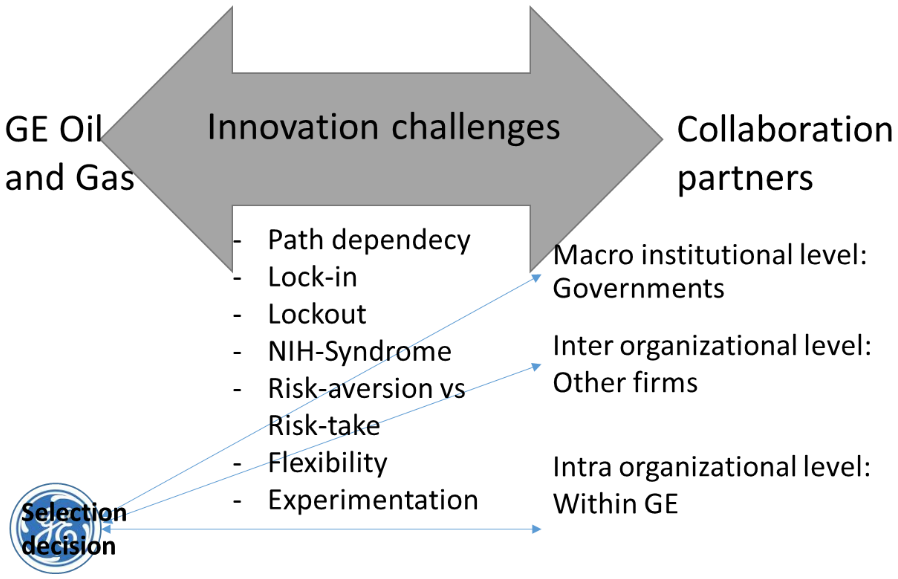

Figure 2: Visualization of innovation collaboration across three institutional levels.

Figure 2 presents how the thesis analyses the selection principles for reviewing innovation initiatives in GE Oil and Gas. The three blue arrows represent how GE Oil and Gas collaborates on three levels when they select innovation projects. The large grey arrow pointing in two directions implies that the innovation factors listed underneath comes into existence when GE Oil and Gas collaborates with partners on three institutional levels. In addition, Figure 2 proposes that institutional factors on all three levels affect innovation selection at GE Oil and Gas, and that each level of collaboration intertwines with innovation factors.

4.2 Qualitative research as a methodology

The case study on GE Oil and Gas has been an intensive single case study of individuals, groups of individuals and an entire organization from October 2013 until May 2014 (Hay, 2010: 370). The flexibility of case-study as a methodology and the tools[8] from qualitative data collection

[8]*Methodology* is referring to the case study as a strategy to understand data, as opposed to a *method* that is a tool to gather data (Punch 2005: 144).

provides the opportunity to utilize any appropriate method for conducting research (Punch 2005: 144). This has been crucial to enable a three level analysis of decision-making at GE visualized in Figure 2.

According to Yin, the case study is appropriate as a methodical approach when the form of the research question is explanatory asking a "how" or "why" question (Yin 2014: 10). All three research questions in this particular thesis are explanatory by posing "how" questions requiring in-depth research to raise sufficient answers. In addition, this case study has been performed from an institutional perspective across three levels. Only a case study with a qualitative design can handle the complexity of studying a decision in-depth on an individual level and at the same time place this decision in a global energy context (Punch, 2005). Also, the three case studies looks at decision making in three very different contexts, aiming to highlight the variation of how innovation initiatives are screened and at the same time illuminate similarities and differences across three cases. Where a quantitative study would exclude many contextual factors and derive answers to statements or a clear hypothesis, a qualitative study allow for contextual comparison (George and Bennett, 2005: 22). For these reasons, the qualitative design is seen as beneficial in order to gather all threads and to answer the research questions raised in this thesis.

I use a single case design placing GE Oil and Gas in an international oil and energy context. At the same time, three embedded case studies have been performed revealing contexts of their own and exploring the same theoretical concepts through different lenses. The case study allows for contextual comparison (George and Bennett, 2005: 19), this is necessary to operationalize institutional factors, to analyse how they deal with the challenges to innovation selection and how they affect the screening of innovation projects. The methodical framework operationalizes theoretical concepts into variables that according to theory have an effect on the future success or failure of innovation projects. The methodical design looks at three dimensions where GE operates (See Figure 2), and therefore it is vital to enable the investigation of complex causal relationships (George and Bennett, 2005: 22). Furthermore, linking the variables from each case to the overall context has been crucial to address the challenges to innovation selection (George and Bennett, 2005:22). For this reason, the researcher has chosen to conduct a qualitative case study.

4.3 Access to case

In the early stages of my research, I was determined to look at decision-making in the screening of innovation projects at a commercial company. I had trouble to find a company who conducted innovation in the close-proximity of Oslo and it was challenging to be confident on the topic itself. Recognizing the limitations of my own empirical and theoretical knowledge, I decided to perform a survey where on 17 organizations from September to October 2013. I used criterion sampling by ensuring that all of them performed innovation (Bradshae and Stratford, 2010).

The first objective with this survey was to see if institutional factors were considered when commercial companies screened innovation projects and examine why a project would be terminated or selected. My second objective was to establish a connection to potential case studies acknowledging how this could be appropriate as a methodology (Yin. 2014: 10-11) since decision-making was at the very heart of the approach (Yin, 2014). The third objective and the main goal of the survey, was to gain insight to how empirical innovation selection actually occurred at commercial organizations. In an informal meeting with an experienced survey respondent from the Oil and Gas industry, I received the contact information to a senior employee at GE Oil and Gas. Referred to as *snowball sampling* in the current literature, receiving information from people who know other people in the industry proved to be how I gained access to this case study (Bradshaw and Stratford, 2010: 75).

GE was rated as one of Norway's most innovative organizations in 2008 (Gram, 2008). With this mind, I got in touch with a senior employee with the senior employee at GE Oil and Gas. After two introduction meetings, the scope of the thesis had been narrowed down into manageable research questions (George and Bennett 2005, 84). I signed an engagement until June 2014 giving me access to three case studies where GE Oil and Gas collaborated with customers or stakeholders on the screening, selection and termination of innovation initiatives. The engagement would simplify and guarantee access to data and potential informants if I performed an embedded single-case study on GE Oil and Gas (Yin 2014). For these two reasons, I decided to go for an embedded single-case design.

4.4 Data Collection

In this thesis, data have been collected from an internet survey of 17 Norwegian innovative commercial organizations, through document analysis from public and confidential records, 42 interviews with 38 informants and 4 official observations. In addition, data was gathered from my desk at GE Oil and Gas where informants were observed in their natural setting. In order to perform data collection in a responsible manner, it is critical to establish methods that ensure trustworthiness to the way qualitative research is conducted (Bradshaw and Stratford, 2010: 77). By applying the principle of triangulation[9], meaning multiple sources, methods, investigators and theories to data collection, trustworthiness enhances the credibility of the results (Bradshaw and Stratford, 2010: 77). Through surveys, interviews, document analysis and observations, data could be collected and interpreted from multiple sources. From collaborating with GE Oil and Gas and by checking with my two supervisors at the University of Oslo, the theoretical framework and the methodological framework was challenged and developed throughout the process and has always been a subject to modification and improvement. The collaboration with GE Oil and Gas gave me access to documents used for contextual purposes before interviewing informants. The documents were also important to retrieve more data from the observations.

4.5 Interviews

Interviews have been the primary source to investigate how collaboration activities influence decision-making, and how the screening of innovation projects were affected by institutional factors on three levels. The strength of the interview to examine complex behavior in-depth, and to highlight the individual perception of each informants has been critical in order to measure the theoretical concepts on the case studies (Dunn, 2010). In addition, by identifying the scope of my thesis into four themes and accordingly four interview guides, all interviews were aimed at retrieving data from informants with relevant knowledge tied to one of the three levels of analysis.

The interview technique has been essential to complete research for this thesis i.e.: From the beginning through informal talks with informants to reach an understanding of the empirical

[9] Triangulation is described further in the section on reliability and validity.

commercialized innovation, and later on as a strategic tool to retrieve data on different topics related to each research question. I decided to perform semi-structured interviews, where I adjusted the interview guide before each interview. A semi structured design set no restrictions for raising new questions or prompts during the interviews (Dunn, 2010: 102). This was seen as highly beneficial since all informants had a lot of experience on the topic in question, accordingly it was not impossible to anticipate the responses I would receive. Also, due to their experience from the industry I had some open-ended questions anticipating that I could also receive information on one of the other topics of interest. This flexibility was necessary with informants from several organizations leading to small question adjustments of the interview guide.

The guide was sent to the informant together with an information letter beforehand to build rapport. Rapport has been defined as establishing a relationship with the informant based on confidence and mutual understanding (Cooper and Schindler, 2003: 329). This provided the interviewer and the informant with a setting where both could feel at ease aiming to generate more insightful and valid data (Dunn, 2010). The information letter described the background for chosen topic, why I wanted to include the informant as a participant and the time and the scope for the interview; All of which were seen as important in order to gain rapport (Dunn 2010: 113).

4.5.1 Conducting interviews

I selected interview participants using two techniques: Criterion sampling and snowballing. All informants were selected on the basis of having met the criteria of having vast experience, competency and knowledge on the topic in question (Bradshaw and Stratford 2010: 75). Criterion sampling was applied to retrieve as much in-depth information on the actual topic as possible (Punch 2005: 187). However, identifying informants with this type of in-depth knowledge on each topic proved to be difficult in some cases. The process of getting in touch with potential informants occurred by email, telephone or even a contact visit. This was time consuming, but seen as important in order to achieve informed consent and to establish a good relationship before conducting the interview (Seidman, 1991: 46 - 47). As a result, even if the potential informant did not want to participate due to lack of experience, I often received advice of potential informants with a lot of knowledge on the matter.

I received contact information to informants from sponsors at GE Oil and Gas. Other interviews came as a result from a snow-ball effect after initial interviews with informants. The interviews were performed at the work location of the informant as long as their offices were in the close proximity of Oslo and accessible by public transportation. If the informant was located elsewhere, the interview was conducted on the phone due to travel expenses and time or at a time when the informant was in Oslo through work.

First of all, it would be difficult to arrange for longer interviews due to busy work schedules of the informants. I planned for each interview to last about one hour for two reasons.. The informants were extremely busy and this was the only opportunity to interview them. In addition, it could be difficult to retrieve desired information if the interview was shorter. On the third case study, I performed interviews *in the field* and these were a lot shorter due to practical reasons Al together, the informants came from a number of organizations aiming to illuminate different individual understandings to each topic. This was important since the overall theme of developing radical innovations was seen as controversial in itself, but also it was beneficial to collect data from informants with various backgrounds (ibid)

Preparations for conducting a successful interview required hours of work. The interview guide was made up of between 5-9 primary questions with secondary prompts on areas to encourage the informant to elaborate on the chosen topic (Dunn 2010: 107). Each interview guide was tested through a pilot interview with an experienced senior employee on innovation at GE Oil and Gas to ensure feasibility (Monk and Bedford, 2010: 325). In addition, my supervisor at the University of Oslo commented on the guide before a conclusion was made regarding the final interview design. The aim was to avoid interview bias from poorly articulated questions in order to ensure trustworthiness and reliability through triangulation of multiple sources on how to interpret the collected data. (Yin 2014: 106).

I applied a procedure where I interacted verbally with all informants beforehand and then sent information about my thesis on e-mail. The informant was also informed that the interview would be recorded and that he or she had to sign a letter of consent (Cooper and Schindler 2003: 326). In addition, the informant could decide where the interview would take place. This routine was not always possible to follow due to lack of time and difficulties in getting hold of some informants. In the first two interviews, I experienced that it was more difficult to establish rapport with my informants and to gain their personal opinion. Before one of these interviews, I did not interact verbally with the informant beforehand. In addition, the interview was conducted in English and on the phone. One reason could be that it was challenging to establish rapport with the informant and to gain access to his personal thoughts and perceptions. Also, I had trouble handling the flexibility which the semi-structured interview provided by giving the informant insufficient explanations to some of the questions along the way. In addition, it was challenging to remain confident, especially when the informant was critical to some of the questions. This lead to some difficulties in knowing when to initiate prompts and to counter the challenges of my personal characteristic as a young female student and social position as a researcher (Dowling 2010: 35).

All informants I interviewed were employees in large corporations or government organizations. I encountered the asymmetrical relationship (Dowling, 2010: 32) between me, the researcher, and the informants who all had powerful positions and dealt with this by involving the perceptions of people of similar power into the methodology work to learn from their experience (Dowling 2010: 33). I received help from senior employees on management level at GE Oil and Gas in reviewing interview guides, introducing me to informants and offering help and support.

To solve some challenges I encountered in the interview context, I decided to transcribe the interviews straight away meaning that I started to analyze the data in January (Punch 2005). This was highly beneficial to reflect on why I was unable to establish rapport[10] and how I could improve my own interview technique before the next interview. By listening to how the informant responded to my questions, I learned quickly how to position myself and to phrase the questions objectively. Several of the informants were highly experienced and it was important to value their opinions. At the same time, the informants could have difficulties to express their personal opinion on some of the questions. I solved this challenge by expressing knowledge on the topic and implemented some of my own subjective opinions. This was highly beneficial because it resulted in an informal discussion where valuable qualitative data was gathered, and at the same time removing barriers the informant previously had felt to communicate his own personal view. Simultaneously, I was careful since this could also affect my objectivity as a researcher, and I found that my subjective opinion on the topic was influenced by the data I gathered. Consequently, I focused on the need to handle the data analysis through critical reflexivity, which was regarded the best strategy to deal with the issues of subjectivity and inter-subjectivity (Dowling 2010: 35). This technique was applied to ensure validity, and to increase reliability by conducting data analysis in the same procedure.

[10] Rapport is…… A more thorough explanation is given in section….

4.6 Observation

Observation could be defined as “taking part in the world and not just representing it” emphasizing various ways observational research may be conducted (Kearns, 2010: 242). Punch (2005: 181) emphasizes that observational research must define what will be observed and why this is of relevance to answer the research questions. I performed four official observations on the 13th of February, 27th of February, 12th of March and 8-10th of April. This thesis uses the techniques by Gold (1958) to describe how observations were performed. I have applied three out of four observation techniques to collect data. I will now describe how observational research was conducted during my thesis.

4.6.1 Conducting research as participant-observer

Observation was particularly important to gather data during the case study in Florence where I conducted research as a participant-observer. When undertaking participant-observation, the informant is aware of the true identity of the researcher (Gold, 1958: 221). I participated in the workshops and the plenary sessions because I wanted to observe the informants in a natural setting as a pure direct observant (Punch 2005: 179). This was necessary to collect sufficient data to answer the research questions, especially the question on how to facilitate radical innovations. I participated directly in how informants screened innovation initiatives and I gained first hand data that would be extremely difficult to retrieve from other sources.

During the case study in Florence, I introduced myself as an intern at GE Oil and Gas conducting a master thesis on innovation management. The workshop gave me a contextual and holistic understanding of how GE collaborated with external stakeholders to develop technology in areas with high institutional risk. I collected data by writing a field diary that was updated every day with important reflections and notes. In addition I took many pictures, had a number of informal talks and 13 short interviews. During the case study, I encountered some situations where I had to deal with the asymmetrical power relationship between the informants and me. Through critical reflexivity, I dealt with these situations by reasoning why I was there, how this was relevant for the topic of my thesis and emphasizing that I valued their perceptions and experience on the case study (Dowling 2010: 33).

4.6.2 Conducting research as complete observer

I conducted observation as a complete observer in two telephone conferences where innovation initiatives were discussed between GE and Statoil. The informants were working on an innovation projects close to deadline and soon awaiting the selection or termination decision. By performing data collection as a complete observer, I was removed from any social interaction with the informants (Gold 1958: 221-222). This method was extremely useful to collect data for contextual purposed regarding how innovation challenges and institutional factors affected innovation selection at GE Oil and Gas. In addition, it gave me insights to how GE performed cross-sectional collaboration internally and how they cooperated with Statoil. Only the informant who provided access to the observation was aware of my participation. The other informants were unaware of my participation (Gold 1958: 219) enabling natural observations (Punch 2005: 179). These meetings gave me a possibility to interpret in-depth through direct exposure how innovation selection was conducted at GE. In addition, this was highly beneficial since the project itself was a project considered on the TCA (Kearns 2010: 242). Afterwards, I transcribed this data like interview transcriptions. Due to ethical concerns, however, it was decided to use the direct observations only to a limited extent in the case study analysis. Overall perceptions of internal collaboration on innovation projects have been used to analyse case study one[11].

4.6.3 Observer as participant

This type of observation is performed participant data collection is performed on a short time-scope and in a formal setting where the data collected is often targeted towards a specific aim or to gain an overall understanding of a phenomenon without going in-depth (Gold 1958: 221). Kearns (2010) describes this technique as being a newcomer in the crowd watching a new sport. I undertook this role from my desk as an intern at GE Oil and Gas, where I gradually gained knowledge to how they worked on innovation projects through informal observations.

[11] Discussed in chapter 4.10.

4.7 Documentation

Document analysis can be defined as the evaluation of historical or contemporary confidential or public records, reports, government documents and opinions (Cooper and Schindler 2003: 152). Documentation has been important to enhance my own knowledge on the contextual surroundings of each case, in addition to explaining and operationalizing theoretical concepts to informants and respondents. This was possible because documentary data can be specific even if it covers a broad topic, in addition of being perceived as unobtrusive for outsiders (Yin 2014: 106). I was careful to gather information from several documentation sources when creating the table profiles trying to prevent biased selectivity and reporting bias. Bias selectivity refers to incomplete data collection, for instance data based on one reference alone. Reporting bias on the other hand points to the fact that a document is influenced of the author in some way or another (Yin 2014: 106).

This method has weaknesses as well and can cause many challenges for collecting data. As a researcher, I experienced that documentation often was time consuming because I was unsure of where to look for information. In addition, it could be difficult to gain access to the desired information (Yin 2014: 106) since I used non-public documents to describe the case studies was. On the one hand, this information was important to reduce bias and to increase validity. On the other hand, I was careful to use documentation primarily for contextual purposes and not as a main source of data. Therefore, these weaknesses could be reduced to a minimum.

4.8 Reliability

Reliability refers to how the case study is conducted. The goal is to reduce errors and bias in the data collection and to ensure that a later researcher can follow the same procedures and retrieve the same results from the case study performed for this thesis (Yin 2014: 49). Qualitative research demands consistency to how the researcher collects, analyses and presents data. By ensuring high levels of reliability and consistency to how qualitative research is performed, the aim is to ensure trustworthiness upon the reader to evaluate how the research has been conducted (Bradshaw and Stratford 2010: 77).

The researcher performed the same procedures in approaching and interviewing (or observing) the informants. In the interview chapter, the reader can find a detailed explanation of this procedure to ensure transparency. Transparency means that enough details are provided so the reader can gain a complete understanding on how the data was collected and analysed (George and Bennett 2005: 106). An overview of major decisions that were undertaken while working with the master thesis is presented in the appendix and the table shows that a lot of time and effort were used to collect and transcribe data.

On the last case study I encountered a challenge to keep the quality of reliable methods to collect data. The informants were on a tight time schedule and therefore it was not possible to use the same procedures on these interviews as the others. Furthermore, I was not given access to the participant list until the day before we left for Florence. Exact research questions and preparations meant that a tolerable level of reliability still could be maintained when data was collected. In addition, transparency have been a focus since the interview guides are attached in the appendix, interviews are recorded and data have been analysed in the same procedure and visualized in chapter 5-8 (Bradshaw and Stratford 2010).

4.9 Validity

Validity is defined as the truthfulness or accuracy of data compared to acceptable criteria (Hay 2010: 391). In other words, validity questions the findings of a study. Validity is extremely important when conducting qualitative research, and therefore I have decided to discuss the term in from three perspectives: construct validity, internal validity and external validity.

It can be challenging to achieve construct validity in case study research. For instance, the methods used to measure an institutional factor. The argument implies that a researchers subjective judgments would lead to a result confirming the researchers preconceived notions (Yin 2014: 46). From the beginning, I dealt with this using by the theoretical framework as a starting point for designing interview guides. In addition, key informants and my supervisors came with comments along the way. Furthermore, I sought to uphold construct validity by interviewing 38 informants from 16 organizations enhancing diversity of data and to counter my own preconceived notions leading to subjective judgments of the data analysis. In addition, informants were given the opportunity to correct all direct citations. Finally, every step of the research has been a subject to revisions and comments from external sources in order to establish an analytical chapter that can present findings with high construct validity (Yin 2014: 46).

In order to perform responsible data collection it is critical to establish methods that ensure trustworthiness to the way qualitative research is conducted (Bradshaw and Stratford 2010: 77). The principle of triangulation eas applied to every step fo the process, maintaining trustworthiness and increased credibility of the implications presented in chapters 5-9. Through surveys, interviews, document analysis and observations, data could be collected and interpreted from multiple sources. Internal validity asserts that rival explanations needs to be considered to the finding of a case study. The researcher chose to conduct qualitative research with interviews as the main source. A challenge to achieve internal validity occurs when informants have to recount for events occurring another point in time. Therefore, documentation and observations became increasingly important in order to achieve internal validity and to clarify rival explanations throughout working with the master thesis (Yin 2014: 47). Through observation, the researcher could perform direct data collection of informants in their natural setting. At times, triangulation was not sufficient to recount for competing explanations. Consequently, the researcher chose to reflect critically when internal validity was threatened.

External validity refers to generalizing results can be generalized beyond the immediate study. Because the researcher chose to conduct a qualitative case study the results of this study cannot be generalized to other case studies. The insights and implications this study comes up with, however, can still be useful for other OEM’s conducting innovation.

4.10 Ethical concerns

It was important for the researcher to consider ethical concerns to justify direct quotations and observations used in the analysis. Detailed information on how the researcher performed ethical considerations towards informants is accounted for in the paragraph “conducting interviews”. Furthermore, the researcher has named all informants with a masculine term to ensure anonymity of the level that was signed and agreed upon by the informants. In addition, the researcher allowed ensures written confirmation of direct quotes used in the thesis to ensure that the informants were comfortable to me mentioned directly in the thesis (De nasjonale forskningsetiske komiteene, 2013).These procedures were also a priority to enable other researchers to conduct a case study on the same object, or collect data from the same participants at another point in time.

4.11 Coding of data

Punch (2005) describes coding as the specific and concrete act where the researcher begins to analyse the collected data with tags and labels (Punch 2005).

I transcribed data from 42 interviews with 38 informants and began the analysis by reading all the documents and pulling out relevant data by sorting it into four categories. The four categories were innovation factors and institutional factors on the three levels described in chapter three. I used theoretical propositions to shape my strategy of collecting and coding data. The interview guides were designed to access information related to these theoretical propositions (Yin 2014: 136). The data material was colored after in relation to four topics and giving value scores accordingly. This enabled reduction of the data material and classification into seven categories. I chose to visualize these factors in 10 Figures to discuss and analyse them in chapter 5-9 because visualization was important to compress the data material into easily understandable graphs (Punch 2005: 198-199).

The institutional factors were divided into six categories on three levels. How this has been done is also recounted for elsewhere in the thesis as well. Information was grouped into patterns that emerging after each interview. Every time a factor appeared, it was given a point from 0-3 regarding how heavily it was emphasized. Afterwards average values and percentage values could be produced and presented in graphs placed in chapters 5 - 9.

I had to address the coding of innovation factors differently because these concepts required a more analytical approach reading more of the text and then grasping the underlying meaning. Figure 4 displays the answers from all informants on innovation factors regarding innovation selection. Each informant were scored on 0, 0,5 or 1 on innovation factors where 0 indicated that the informant did not mention the factor at all, 0,5 indicated that the informant perceived the challenge to some degree, and 1 meant that the informant showed significant marks of this challenge. I entered all the values into an excel document where I looked for similarities or differences that would make up a pattern to confirm, extend or disprove the research questions (Yin 2014: 143).

Code	Position	Organization	Length	Date
GE1	Mid-level Manager	GE Oil and Gas	90 minutes	18.02, 06.03.2014
C3A	Top Manager	Houston Advanced Research Center	5 minutes	08.04.2014
C3B	Top Manager	Texas Institute of Science	5 minutes	08.04.2014
C3D	Senior Associate	Repsol	5 minutes	08.04.2014
C3E	Top Manager	Petoro	5 minutes	08.04.2014
C3G	Top Manager	The Norwegian Ministry of Oil and Energy	5 minutes	08.04.2014
C3H	Top Manager	The Swiss Federal Office of Energy	5 minutes	09.04.2014
C3I	Top Manager	American Petroleum Institute Washington	5 minutes	09.04.2014
C3J	Top Manager	Interstate Compact organization	5 minutes	09.04.2014
C3K	Top Manager	DNV GL	5 minutes	09.04.2014
C3L	Top Manager	EDF	5 minutes	09.04.2014
C3M	Top Manager	DNV GL	5 minutes	09.04.2014
GE10	Manager	GE Oil and Gas	45 minutter	06.03.2014
GE11	Associate	GE Oil and Gas	60 minutes	10.03.2014
GE12	Associate	GE Oil and Gas	30 minutes	10.04.2014
GE13	Associate	GE Oil and Gas	60 minutes	27.03.2014
GE14	Mid-level Manager	GE Oil and Gas	90 minutes	28.03.2014
GE15	Mid-level Manager	GE Oil and Gas	30 minutes	10.04.2014
GE16	Mid-level Manager	GE Corporate	5 minutes	08.04.2014
GE 17	Top Manager	GE Corporate	30 minutes	11.03.2014
GE2	Senior Associate	GE Oil and Gas	90 minutter	10.03.2014
GE3	Senior Associate	GE Oil and Gas	60 minutes	27.02.2014
GE4	Senior Associate	GE Oil and Gas	40 minutes	07.02.2014
GE5	Senior Associate	GE Oil and Gas	40 minutes	06.03.2014
GE6	Senior Associate	GE Oil and Gas	45 minutes	06.03.2014
GE7	Senior Associate	GE Oil and Gas	140 minutes	11.02, 28.02.2014
GE9	Top Manager	GE Oil and Gas	70 minutes	22.01, 28.02, 10.03.2014
Grc8	Top Manager	GE Global Research	120 minutes	18.02.2014
IN1	Senior Associate	INTSOK	90 minutes	07.02.2014
OD1	Senior Associate	Norwegian Petroleum Directorate	75 minutes	19.02.2014
SI1	Top Manager	Anonymous	45 minutes	03.03.2014
ST1	Mid-level Manager	Statoil	60 minutes	17.02.2014
ST2	Senior Associate	Statoil	45 minutes	10.02.2014
ST3	Top Manager	Statoil	60 minutes	21.02.2014
ST4	Top Manager	Statoil	60 minutes	06.03.2014
ST5	Mid-level Manager	Statoil	60 minutes	26.02.2014
ST6	Top Manager	Statoil	5 minutes	08.04.2014
ST7	Top Manager	Statoil	10 minutes	02.05.2014

Figure 3: Overview of all interviewed informants.

5 Empirical Introduction

This chapter describes how radical innovations have been important to the development of oil and gas as valuable commodities on the world market. Furthermore, the chapter outlines how institutional factors have been integrated into technology development after the industry engaged in petroleum activity on the Norwegian Continental Shelf. Finally, the chapter introduces some of the factors (challenges and opportunities) companies in the industry encounter in the selection of innovation initiatives.

5.1 Introduction to innovation challenges in the oil and gas sector

Petroleum is a general term to describe crude oil and natural gas that are nonrenewable mixtures of substances based on hydrocarbons usually referred to as fossil fuels. Petroleum established its position as a valuable commodity on the world market in the 1850s (Geo-Help Inc, No Date). Radical innovations like the modern oil well enabled exploration of oil and gas, the oil refinery allowed production and the cerocene lamp established a market to sell the commodity. The innovation enabling transportation of oil and gas by ship became the door opener to the global market creating the global commercial oil industry and by the turn of the 20th century, oil production arose internationally (Business & Economic Research Advisor, 2006).

According to the theory on innovation management presented in chapter 3.1, path dependency and the following effects of path dependency, lock-in and lockout, in addition to NIH-syndrome and inertia are vast challenges to successful innovation selection in the oil and gas sector. The challenges inter-relate with each other and often arise at the same time if a company proves to have difficulties in handling one of them. For companies suffering from these challenges it is very unlikely to succeed in developing radical innovations. In the same chapter theoretical arguments identifies selection principles to counter these challenges by introducing external knowledge flows that can identify promising innovation initiatives. The argument set forth in chapter 3.4 demonstrates that selecting innovations accredited high opportuntites to succeed and a high risk of failure are measures to increase the potential of ROI from the innovation portfolio. Therefore, companies are stressed to withstand risk-taking and experimentation in the selection of innovations

Innovation Factors	Total value score
Path-dependency	61 %
Lockout	53 %
Lock-in	45 %
NIH-syndrome	40 %
Inertia	39 %
Risk Taking	17 %
Experimentation	12 %
Flexibility/Fastworks	11 %

Figure 4: Displaying total the value score of 38 informants on innovation factors

Figure 4 presents a ranking of the total value score given each innovation factor across interviews with 38 informants. Each factor received the value 0 meaning the lowest, 0,5 and 1 which was the highest value according to how strongly the informant emphasized interview. The length of the interviews vary as shown in Figure 3. The interview guide presented in each case study were different (see appendix). Therefore, the results in Figure 4 can only make suggestions to how each factor affects innovation selection. The innovation factors in Figure 4 with a white color are hindering innovation selection the higher percentage support they receive. The innovation factors in Figure 4 with a blue color have the opposite effect, and induces the selection of viable innovation initiatives the higher support they receive.

Path dependency has been valued as the biggest challenge to innovation selection within the oil and gas sector across all the interviews. Furthermore, results from the interviews, regardless of organization, indicates that lock-in, lockout, inertia and NIH-syndrome are major challenges to innovation selection confirming that path dependency often leads to these effects as well. An interesting result, however, emerges from the lack of values given to experimentation, risk-taking and flexibility in Figure 4. Companies that have high levels of experimentation, risk-taking and flexibility within their organizations are more successful in identifying radical innovations (Chesbrough, 2003). These factors open up for external knowledge flows and external competency that affects the intra-organizational selection principles. Companies lacking these factors are increasingly path-dependent and incapable of identifying the innovation initiatives with the highest potential of success. The three case studies will analyse these findings into detail in order to gain a complete understanding of how the factors in Figure 4 affect innovation selection at GE Oil and Gas.

5.2 Introduction to path-dependent behavior in the oil and gas sector

The theoretical argument presented in chapter 3.1 emphasizes that it is especially difficult for large and established companies to recognize competing technology paths and to apply this technology for internal innovation. These companies have challenges in adapting to a new mindset from leading scientists dominating the new energy landscape. When narrowing the graph down to informants who have expressed the prevalence of path dependency in Figure 5, it is striking to see that informants from GE has the lowest percentage rate of informants per organization who has valued path-dependency as an innovation challenge in the oil and gas sector. A low percentage rate of path dependency enables the company to identify successful innovation initiatives based on technology from a competing technology path.

Company	Informants expressing path dependecy
GRC	100 %
Other	93 %
GE	57 %
Statoil	44 %

Figure 5: Percentage value on path-dependency per company.

At GE, informants expressing values of path dependency, refers to the customer's reluctance in supporting radical technology. GE identify some customers in the sector to be path-dependent, this can lead to a lockout effect where it is very risky and costly for the GE Oil and Gas to develop radical technology. Furthermore, this increases GE's difficulties to qualify[12] new technology and reaching the target of "proven" from customers.[13] This seems to be especially difficult in the oil and gas industry, and is a barrier for GE Oil and Gas to select radical technology ideas. Here described by a mid-level manager in GE Oil and Gas:

In the selection of radical innovation projects, cost and benefits have to be assessed, and the consequence of failure needs to be estimated. Just think about Macondo[14] – the industry is allergic to risk. The sector will remain conservative – I am certain about that (GE14, 28.03.14).

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[12] Qualification of new technology is an institutional factor presented in Figure 9 and discussed in chapter 6.5.1.
[13] "Proven" is an institutional factor presented in Figure 8. Proven stands for the customers approval of new technology and will to take the technology into use.
[14] Macondo represents a gas release and subsequent explosion occurred on the Deepwater Horizon oilrig working on the Macondo exploration well for BP in the Gulf of Mexico. 11 people died, and hydrocarbons leaked into the Gulf of Mexico for 36 hours (EY 2014).

Informant GE14 from GE Oil and Gas clearly thinks that the risks of introducing new technology are higher than the benefits they can provide the industry. He describes the Macondo accident as a lockout effect reinforcing path dependent behavior in the oil and gas sector. In the competing technology path, climate change and environmental pollution[15] is a reason to engage in technology development. In the new energy landscape with increased competition from other energy sources, selecting and succeeding with radical innovation initiatives can be paramount to deal with future problems facing the oil and gas industry. This informant from GE corporate emphasizes the need for a joint approach:

> *Well, as the industry really faces the significant challenges of the future – going deeper, going offshore, going into unconventional reservoirs, going into harsh environments, there is a great need for increased technology. This challenge is almost by definition long-term in my view. This addresses, to me, one of the singular important problems in the oil and gas industry: We are driven, and the management of different companies are driven, by the 90 day cycle of Wall Street – what are your numbers, what are your costs this quarter, next quarter – if we're lucky early next year. Therefore, the strategic direction and vision has been lost (GE16, 08.04.14).*

Informant GE16 perceives the industry as conservative and recognizes that the risks of developing technology to solve long-term problems have lead to a lock-in effect where companies spend resources on innovations with less risk dealing with short-term challenges.

The challenges for selecting radical innovations seem to concern how GE Oil and Gas work with their customers and stakeholders. The next chapter will introduce Statoil, an external innovation collaboration partner to develop innovation initiatives on all three case studies. In addition, the section outlines how collaboration between the industry, the government and the academia has built the Norwegian Petroleum Industry. This background is important to understand why institutional factors affects the selection of innovations and how institutional factors on three levels can affect the selection principles at GE Oil and Gas.

5.2.1 Development of oil and gas technology on the Norwegian continental shelf

The Norwegian petroleum story began in the 1960's after petroleum was discovered in the Netherlands. This discovery attracted the attention of international oil companies to apply for

[15] That also includes oil spills.

concessions and soon the Norwegian government decided to establish formal macro institutions, national laws and regulations, to regulate Petroleum activity on the Norwegian Continental Shelf. These institutions meant high taxation of potential revenue and fixed control of potential exploration activity after the discovery of the first oil field Ekofisk in 1969 with production beginning in 1971 (Ministry of Petroleum and Energy, 2013). Important political and economic instruments ensuring social welfare and industrial growth were created when Statoil, the National Petroleum Directorate (NPD) and Ministry of Petroleum and Energy (MOPE) were established in the 1970's. The state applied regulations to slow down the distribution of concessions to international companies aiming to develop local content through education and training of Norwegians, and in turn build a domestic knowledge base to benefit from the petroleum industry. Local content was an effect of formal institutions and worked to counteract unemployment by creating jobs and developing a new local industrial capacity from a new competence base. Statoil, the national Norwegian oil company, became the predominant public instrument for ensuring and developing local content. Statoil used industrial networks for training and transfer of knowledge and technology to build a competitive Norwegian industry (Engen, 2009).

The Norwegian model of controlling the petroleum industry, claiming taxes and distributing resources benefitting the vast majority of Norway's population, became a radical way for governments to manage oil and gas exploration. The effect this model had on the Norwegian society and the construction of the welfare state was unique compared to any other oil producing country in the world. A mid-level manager from Statoil described this model as the most important radical innovation Statoil has developed:

> *The one radical innovation from Statoil is how we have worked with the government and the local industry to construct a framework for innovation and local technology development. This model is unique compared to any other NOC*[16] *in the world, and it has triggered sustainable growth to the Norwegian national economy. This is what we call the Norwegian model (ST1, 17.02.14).*

The Norwegian model required the creation of an entirely new infrastructure where Statoil itself contributed greatly. Informant ST1 emphasized Statoil's choice to use local suppliers to develop technology and innovation as the key to trigger sustainable growth in Norway. A mid-level manager in GE Oil and Gas confirmed that if a customer complied with local rules and

[16] Abbreviation for National Oil Company (NOC).

regulations emphasizing local content, this would affect how GE conducted innovation and technology:

> *Governments often have a local content requirement for new field development*[17]*. This becomes a commitment by the operator to design a procurement strategy so that local suppliers can do a certain part of the scope of supply. As a supplier entering a new country, GE Oil & Gas must meet this requirement in various ways like e.g. placing low-tech basic steel fabrication jobs with local sub-suppliers and follow up closely to ensure quality. The hi-tech part of the scope and the overall design work will still have to be done from home. (GE1, 18.02.14).*

Informant GE1 indicates that laws and regulations on a macro level can directly affect innovation projects by imposing GE Oil and Gas to use local content in the innovation process. The application of local content can enhance commercial viability in a number of ways. Local content can reduce exploration costs if the company hires a local workforce instead of paying salaries and transportation of expats. Local content can also reduce institutional risks by reducing local opposition through implementing measures to ensure that the local population receive benefits (Olsen 2014), ensuring a smooth operation in a developing country. In addition, local content coheres with idea of obtaining a social license to operate that has increasingly received more attention in the last years. In order to receive a social license, the oil company needs to perform petroleum exploration, extraction and production cleanly and sustainable (Siddiqi, 2014).

For an industry based on extracting hydrocarbons, conducting business environmentally sustainable is very difficult. Developing this technology has proven to be extremely costly – companies are risking a combined lockout: Lockout from emerging technology paths, and as a result, a lockout from the new energy landscape.

5.2.2 GE Oil and Gas as an embedded case study

The entire GE-corporation has 300.000 employees working in more than 140 countries, but GE Oil and Gas has 43.000 employees operating in more than 100 countries and across seven business areas[18]. In the last three years, GE has invested more than 1 billion dollars on research and development (R&D) resulting in more than ninety new product launches in 2012 (The Economist, 2014). GE Oil and Gas performs innovation in three ways: through new production

[17] Exploration of a new petroleum field.
[18] See the appendix for an organization chart of GE Oil and Gas.

innovation (NPI), new technology innovation (NTI) and internal research and development (ITR) (GE 5, 05.03.14). According to Vice President Rod Christie, the focus for GE when it comes to innovation is to work closely with customers, understand the challenges they are facing and develop technologies or solutions to meet their needs (The Economist, 2014). A senior associate accounts for this:

> *If it is a strong business case and we have the competency available – we would like to develop the project. Earlier when only the technologists in both companies indicated that this was interesting, the projects often ended up into a solution nobody needed. Today we have a stronger focus on a business case: That the project is well embedded in both companies (GE7, 28.02.14).*

Informant GE7 from GE Oil and Gas identifies the business case as a tool to facilitate innovation projects if a common business need exists in both companies. At the same time, this citation indicates that the business case is also a mechanism enabling customer collaboration and open innovation. Therefore, a preliminary proposition implies that the recent focus of using the business case as a selection tool at GE Oil and Gas can facilitate the selection of radical innovations based on the theory presented in chapter 3.4.

Another example where GE collaborates with stakeholders to develop innovative solutions are joint industry programmes (JIPs). JIPs are conducted together with two partners or more. According to the literature on PPM, sharing risks can enable ownership for the user and increase the possibility of developing a successful solution increasing the potential of return on investment. Both JIPs and the business case are selection principles that are favourable for GE if they want to convince the customer to engage in development of a radical solution based on technology from a competing path (Tidd and Bessant, 2009). For Statoil, the potential of including technological innovation across all business units makes GE a particularly interesting collaboration partner. In addition, GRC, a part of GE with competency across many R&D areas, possess expertise beneficial for on innovation projects (The Economist, 2014). The theory on open innovation recognizes the ability to open up for knowledge flows[19] from different technologies as a prerequisite to identify radical innovation initiatives with a high potential to succeed. In the selection of radical innovations, this is especially important, since these ideas would be subject to innovation challenges complicating the screening process. Changing the work method towards the business case may be one reason why employees at GE Oil and Gas value path-dependency considerably lower than informants from other organizations.

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[19] See section 3.2.1 on open innovation.

The theoretical tools for managing innovation presented in chapter 3.4 emphasize that some formal routines of the innovation process is necessary. Allocating resources of the company between incremental and radical innovations can give a higher ROI across a portfolio of innovations. Basing the selection decision on knowledge from a variety of sources outside of the traditional economic ones may increase the possibility of success. In addition, multiple considerations of the innovations along the way is highlighted to reduce resource constraints. The theory also recognize radical innovations to arise outside of the formal procedure of innovation management (Tidd and Bessant, 2009). Consequently, the company should have the ability to catch these ideas and incorporate them into the Funnel, or create a separate Funnel for radical ideas. The business case and JIP’s are tools to ease innovation selection and facilitate radical innovations. The next chapters will analyse the proposition that institutional factors affects innovation selection strongly. Furthermore, the analysis examines selection principles GE Oil and Gas use to facilitate the selection of radical innovations. Finally, the researcher will present implications to how GE Oil and Gas can increase the potential of their innovation portfolio by developing successful radical innovations.

6 The Technology Cooperation Agreement (TCA) with Statoil

GE has delivered equipment to Statoil since 1985. Over the last years, the relationship between the two companies has become tighter. Before, when the relationship involved less interaction, GE Oil and Gas developed this equipment through a closed model of innovation which has been described in chapter 3.1. Today, the theory suggests that GE Oil and Gas would develop equipment to Statoil through a more open model of innovation since they enjoy a closer customer-supplier relationship (Thoma et al., 2014). This embedded case study examines the Technology Collaboration Agreement (TCA) established in 2008 that is a formal agreement regulating inter-organizational collaboration. When the analysis refers to projects “on the TCA”, it refers to projects that are run between Statoil and GE regulated by the TCA. The agreement has become the overall platform for cooperation between the two companies and the TCA has been crucial to establish foundations for a relationship between GE and Statoil with increased interaction and communication in recent years (Thoma et al., 2014).

Statoil see many opportunities in cooperating with GE and expects them to deliver the same quality on innovations from all business areas (Thoma et al., 2014). The TCA is an agreement with several terms and conditions, including clauses covering IP[20], confidentiality, and user rights. The contractual clauses are created to remove formal barriers for technology collaboration (Thoma et al., 2014). These clauses are referred to as formal inter-organizational factors because they regulate how the two companies interact. The agreement has been successful in building trust between the two companies, and Statoil perceives GE as a strategic partner as opposed to “only” an equipment supplier. The two companies interact regularly through a number of informal and formal events where they can share knowledge throughout the year. The two companies enjoy an open and direct dialogue (Thoma et al., 2014).

The TCA has four steeringcommittee meetings in a year. The steering committee meeting works as a selection principle where Statoil and GE Oil and Gas consider innovation initatives. The formal agreement has been initiated for a period of three years and then renewed for another three years. The agreement has a mandate to incorporate innovation initatives into an overall TCA project administration and separate focus areas. The focus areas targets

[20] Intellectual property

innovation and technology development on areas of mutual interest for both companies including petroleum, shale gas and renewable energy. Renewable energy utilize technologies from a competing path in the new energy landscape. The agreement focus primarily on bilateral projects funded 50:50 by each part (Davies and Slagsvold, 2014). With the TCA, GE believes that sharing strengths in resources and technology with Statoil can enable both companies to achieve better results and to unlock a potential of added technology value to innovation projects if the companies are successful (GE Oil and Gas, No Date). The stakes are high, aiming to conceive selection principles that can introduce solutions to move mountains. The TCA has been created to provide an institutional framework to allow seed projects run and gain momentum through collaboration and investment. The agreement demands willingness from both parties to explore new technology paths and build a business case together. The objective has since the beginning been to generate an open dialogue to foster the best and brightest ideas and to increase enthusiasm in both companies (GE Oil and Gas, No Date). The following case study will analyse how innovation factors and institutional factors have affected the selection of innovation initiatives on the TCA.

6.1 Analysis of innovation factors

Innovation factors are divided into two groups: Challenges and opportunities. Figure 6 and Figure 7 gives an overview of the average score each informant from the three categories have valued eight innovation factors. Maximum value per factor is 1 and the minimum value per factor is 0.

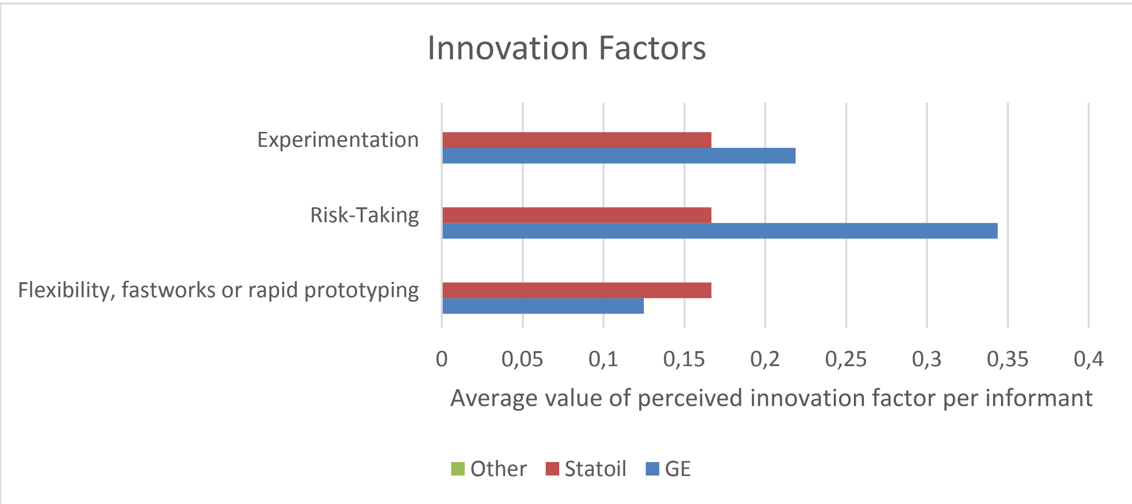

Figure 6: Average perceived value on innovation factors.

Figure 6 indicates that GE's employees value the challenges to innovation selection, path dependency, its effects lock-in and lockout, and inertia lower than informants from other organizations. GE Oil and Gas can leverage from a history of successful innovation introductions in other business units. Furthermore, the researcher observed an unwillingness of informants from GE Oil and Gas to criticise internal innovation initiatives in the interview setting. Furthermore, GE's opportunity to include several technologies when selecting of innovations is emphasized by innovation literature in chapter 3.1 as a measure to counter innovation challenges in Figure 6.

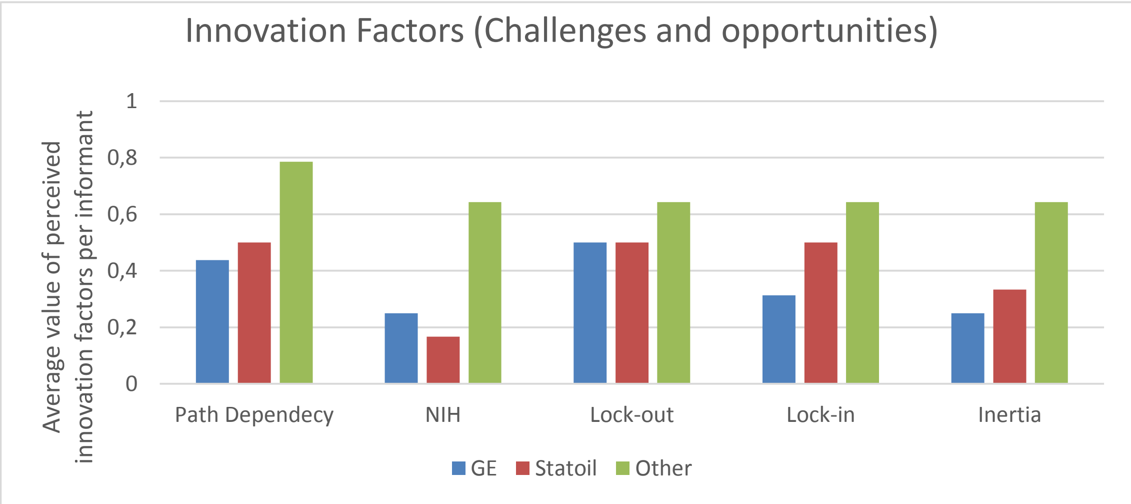

Figure 7: Average perceived value on innovation factors.

Compared with Statoil, GE has a lower awareness of innovation challenges and a higher awareness of factors considered positive for innovation selection, except for flexibility, as shown in Figure 6 and Figure 7. Consequently, the empirical information suggests that GE Oil and Gas should be able to identify radical innovation initiatives, possess the selection principles and have reasonable good chances of launching their iniatives with success. Still, the TCA has proven to be unsuccessful in developing radical innovation initiatives and therefore the analysis starts with flexibility – as the one factor where they have a lower score than Statoil.

6.1.1 Flexibility

The theory indicates that flexibility can be obtained by utilizing the "adequate tools" for innovation management. One tool is the Stage-Gate system that leaves little flexibility in the selection of innovations. Another tool is The Funnel providing more flexibility and enabling the decision maker to consider resource constraints and re-order priorities between innovations throughout the process. The TCA consists of a number of formalized structures that are more complex than regular management systems for innovation projects. A top manager in Statoil expresses his opinion on how these structures have lead to improved innovations:

> *The TCA has a bureaucratic management structure unlike other frame agreements and JIP's (...) We need less complex management, faster contract negotiation and an easier commissioning practice than what we have today. Additionally we must focus on a few, high potential projects (good business cases) that have a high likelihood of being implemented (ST3, 21.02.14).*

The top manager from Statoil underlines flexibility as a major subject of improvement and seeks selection principles that are faster, simpler and less complex to succeed with innovations on the TCA. Furthermore, flexibility is lost when Statoil has limited resources to commission innovation initiatives. In addition, radical innovation projects have failed at meeting project objectives and have been abandoned after implementation of the new technology. A senior associate at GE Oil and Gas explains why they did not succeed:

> *We have tried to develop some radical initiatives based on nano-technology. We were not very successful and the projects were abandoned (...). In one of the projects, we did realise that we needed to understand better the basic technology. With more time, we might have been successful. The project did not give the results we were hoping for – so we decided to shut down that one as well (GE7, 28.02.14).*

Informant GE7 clearly states that they have selected radical innovations. However, succeeding with radical innovation projects within short time limits, have been challenging on the TCA. Furthermore, informant ST3 emphasizes that the lengthy negotiations of terms and conditions (T&C) between Statoil and GE Oil and Gas have been a burden and could be one of the reasons why radical innovations have failed after selection. Consequently, the lack of flexibility on the TCA affects the selection of innovations negatively. Improvement of the rigid structure may facilitate the selection of radical innovations. Simplifying negotiations may enhance the potential to succeed with radical innovations on the TCA.

6.1.2 Path dependency, Lock-in, Lockout, Inertia and NIH-syndrome

The case introduction and the innovation challenges presented in Figure 6 indicate that GE has a higher possibility to facilitate selection of radical innovations than other companies. For instance, GE has the ability to draw on technology from a variety of business units and to avoid lock-in and lockout. In addition, GE applies business cases[21] in innovation selection that counters NIH-syndrome by accessing the core knowledge and the commercial dimension of an external partner. Therefore, answers from informants valuing GE Oil and Gas as path dependent needs to be examined to understand why the TCA has not been successful in introducing radical innovations.

These informants describe GE Oil and Gas as path-dependent with a strong focus on acquiring technology companies. The theory defines path dependency as making decisions and acting them out based on previous experience. GE has a history of technology acquisitions and the company seems to have continued with this practice in the Oil and Gas business unit. The business unit consists of a number of recently acquired companies put together into one organization. A senior informant says *«There have been many acquisitions with interesting technologies, and surely people can ask themselves the question whether they should stop now and try to develop something from the acquired companies"(*GE7, 28.02.14). Informant GE7 indicates that GE Oil and Gas is clearly marked of the high number of recent technology acquisitions. The focus of acquiring new technology companies instead of spending resources on internal innovation may have created a lockout effect from innovations based on technology from a competing path. Instead, the informant and the empirical information indicates that GE Oil and Gas has been locked into a path of acquiring technology companies being one reason why the TCA has not been successful to develop radical innovations.

Several informants from GE Oil and Gas indicate that NIH-syndrome is a challenge for innovation collaboration with recently acquired companies. An informant describes his experience on the matter: *"There is a danger that a lot of small kingdoms exist with the recent acquisitions, and they think they have to guard their territory- that can be a problem for innovation projects" (GE13, 27.03.14).* Informant GE13 states that the recently acquired companies have not been eager to share their core technology. Innovation challenges closely relate, and the newly acquired companies may have been reluctant to share their technology

[21] The business case is explained in chapter 3.4 where companies create an alternative selection principle for radical innovations.

with because new routines to manage innovation can meet resistance, or inertia, which is inherent in all individuals. Informants from GE Oil and Gas have indicated that inertia and NIH-syndrome have delayed innovation projects. With the ambitious objectives of the TCA lies the potential of sparking inertia: "moving mountains". The theory acknowledge that the creation and acceptance of radical ideas, assuming that radical ideas are needed to move mountains, require an environment open for external knowledge flows outside the company's core area of expertise. An associate in Statoil describes in his words:

The TCA has existed for some time without any major results, but I think it has been a learning process to identify the promising projects that both GE and Statoil can benefit from. I think we will see some of these projects in 2014, and we will have to find these projects as well to be allowed to continue on the TCA (ST2, 10.02).

Informant ST2 highlights how both parties, GE and Statoil, can learn from unsuccessful innovations and redeem stronger incentives to identify a business case as a common selection principle. Chapter 3.4 refers to the business case as a tool to facilitate the selection of radical innovations on one hand. On the other hand, the analysis has found that the business case is also a new path that can affect the selection of innovations on the TCA and reduce the risks of developing radical ideas by increasing their potential to succeed.

6.1.3 Experimentation and risk-taking

Several informants describe Statoil's turn in cutting costs as a challenge to succeed with radical innovation initiatives on the TCA. Figure 7 presents GE Oil and Gas with a higher value on risk-take and experimentation than Statoil. Radical projects have higher risks, and often include experimentation of new technology outside the established path of the sector. Therefore, they also tend to be more expensive, however redeeming higher ROI if they are successful. The recent turn to cost-efficiency may explain why Statoil has a lower value on experimentation and risk-taking than GE. Statoil is the end user who takes the vast amount of risk with radical initiatives. At the same time, one of their main objectives with the TCA is to develop technology together with GE based on technology from other business units.

A mid-level manager at GE Oil and Gas illuminates why GE can afford to experiment and take higher risks than Statoil:

We try to build confidence towards Statoil by explaining that this is something GE wants to work with, promote and stand behind. We are willing to share a risk of developing the project and we promote this towards Statoil because we are in a fortunate position regarding the overall access to resources at GE (GE10, 06.03.14).

Informant GE10 explains that GE Oil and Gas are in a position to take risks. Lack of experimentation and risk-take from Statoil is a challenge to engage in innovations on the TCA. Despite of Statoils turn to cutting costs, they still aim to develop radical technology on the TCA. The analysis enhances the importance of taking risks and experimenting with technology from competing technology paths to improve the results of the TCA.

Summary

- Lengthy negotiations with Statoil on T&C's and pressing time limits is a hinder to succeed with viable innovation initiatives. The analysis identifies a requirement for faster, simpler and more flexible tools to manage innovation selection. Implementing the business case is suggested to facilitate radical innovations by improving selection priniciples on the TCA and enhacing flexibility which the analysis has revealed to be challenge for innovation selection at GE Oil and Gas.

- GE's focus on acquiring technology companies in the oil and gas business unit creates challenges to innovation collaboration. Inertia and NIH-syndrome from these firms have been a hinder. These challenges can be reduced if projects are selected based on a common business need using experience from the first six years on the TCA.

- For Statoil, the lack of will to experiment and take risks have been a challenge to facilitate the selection of radical innovation initiatives. GE Oil and Gas on the other hand can take more risk. The analysis suggests using past experiences to avoid major pitfalls can improve innovation selection and implement initiatives in accordance with the TCA objectives.

- The analysis concludes that these difficulties alone are not the hinder for the selection of innovations on the TCA and furthermore the facilitation of radical innovations.

6.2 Informal inter-organizational challenges

A master thesis has clear limitations on pages and time. Therefore the researcher has chosen to conduct an inter-organizational and intra-organizational analysis on this case study only, due to the possibility of many repetitive arguments. Implications regarding how macro institutional factors affect the selection of radical innovations is discussed in the two remaining case studies. Before addressing the first institutional analysis, it is important to remember that the formal and informal factors discussed throughout chapter 6-8 have been created to facilitate successful innovation initatives. Therefore, when they are are affecting the selection of innovations weakly or are affecting the selection of innovations negatively, this is stirring.

The analysis begins with institutional factors affecting decision making at GE Oil and on an inter-organizational level. Do formal or informal institutional factors affect the selection of innovation initiatives strongly on the TCA? Figure 8 presents an overview of inter-organizational factors affecting innovation collaboration between GE Oil and Gas and Statoil. The factors above the blue line represent informal institutional factors, and the factors below the blue line are formal institutional factors. The values have been calculated from the emphasis they were given in the interviews on a scale from -3 to 3, where 3 means that the factor has been heavily emphasized. Furthermore, if the informant meant that the factor affected innovation selection very positively, the value was doubled to emphasize these implications. The values presented in Figure 8 incorporate the average value across all informants per factor.

Figure 8 implies that informal factors affect innovation selection a lot stronger than formal institutional factors. Furthermore, the values indicate that every institutional factor except for the "steering committee" and "GE delivering on time", two formal factors, are valued to affect the selection of innovation initiatives positively. The theoretical suggestion based on institutionalism, that formal factors creates informal ties seems to add up with the results in Figure 8 where many informal ties have been valued as beneficial for innovation selection. At the same time, informants do not value formal factors regulating how Statoil and GE interact as very beneficial for innovation. Accordingly, it is interesting to see how institutional factors on an inter-organizational level affect the selection of innovation initiatives on the TCA.

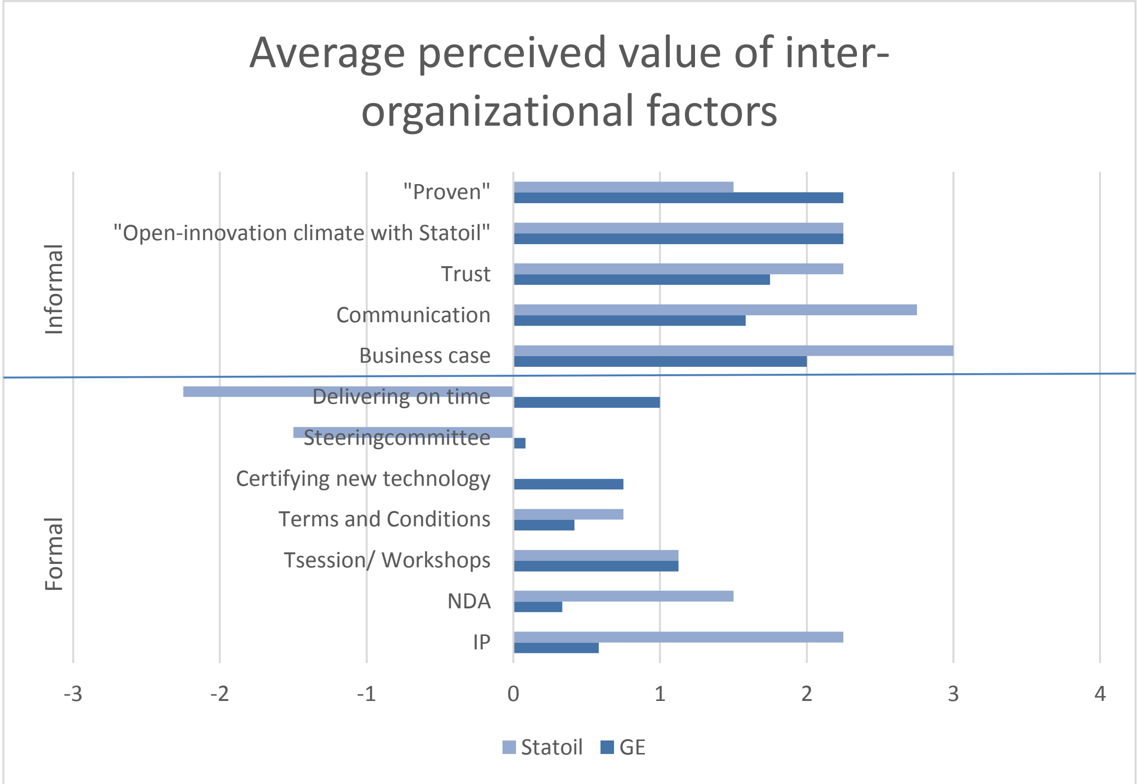

Figure 8: GE and Statoil's value score of inter-organizational institutional factors.

6.2.1 Inter-organizational differences on what is "Proven"

"Proven" is defined as an informal factor because the concept have no precise or formal standard. It has variations depending on the customer-supplier relationship. Figure 8 indicates that gaining the customers approval, or "proof", on new technology is severely affecting how GE Oil and Gas consider innovation initiatives. This coheres with the theoretical argument from PPM and institutionalism, that suppliers initate in customer collaboration to reduce risk on innovation projects. Risk is reduced from the suppliers side through receiving the customers consent on new technology. Statoil is often incorporated from the start on innovation projects and therefore it is reasonable to suggest that "proven" strongly affects the selection of innovations. A senior associate at GE Oil and Gas explains the importance of receiving customer's approval:

"If the solution has been tested solely by GE – probably it is not good enough based on what you already have in the market and it can be very difficult if the technology is not proven. Statoil would probably like to be a witness to approving new technology as well" (GE6, 06.03. 14).

Informant GE6 describes collaboration and the customer's approval as crucial to succeed with radical technology.

Statoil thinks approval of new technology is important, but not to the same extent as GE according to Figure 8. Statoil is an operator with the opportunity to choose between several technology-suppliers whereas GE Oil and Gas relies on receiving Statoil's approval to launch innovations and redeem ROI. Therefore, this institutional factor is very important to consider when GE Oil and Gas select innovation initiatives. The analysis suggests that a good customer-supplier relationship may inter-relate to receiving Statoil's approval of radical technology. Consequently, this factor can be crucial to facilitate the selection of radical innovations on the TCA and increase their potential.

6.2.2 Establishing a good customer-supplier relationship

The theoretical framework in chapter 3 is based on the notion that companies no longer perform closed innovation, but increasingly engage in open innovation with external partners. In Figure 8, both companies agree that establishing an informal relationship of open innovation is affecting the selection of innovation initiatives strongly. Each customer-supplier relationship is unique and building an informal relationship enabling open technology discussions seems to be important, especially for Statoil according to Figure 8. They appreciate open and straightforward technology discussions, and therefore building trust with GE Oil and Gas on the TCA is crucial to achieve discussions on radical innovations. Neo institutionalism emphasizes that trust is a necessity to enable knowledge flows and learning to facilitate radical innovations on innovation collaboration. This underlines the statement in the case introduction, that the TCA has been a platform to grow a closer supplier-customer relationship.

Inter-organizational theory implies that a lack of communication on innovation collaboration between two companies leads to a climate where it is difficult to identify promising innovation initiatives. Figure 8 indicates that Statoil values communication with GE as a factor strongly affecting innovation projects on the TCA. A mid-level manager from Statoil describes communication with GE Oil and Gas in this way: *«I find it easy to communicate with GE, they are open and understanding" (ST2, 10.02.14).* The theory on open innovation implies that informal interaction between two collaboration partners leads to improved selection principles. Consequently, one can draw a conclusion that GE Oil and Gas and Statoil enjoy a very close relationship on the TCA promoting the selection of viable innovation initiatives. On one hand, this is essential to lay the foundations for radical innovations. On the other hand, perhaps this has taken the focus away from developing radical innovations. An employee in GE Oil and Gas shares his opinion on this matter: «*Building the TCA was the first priority when I started in the job as Global Account Executive. The main goal was to create a communication arena on a management level" (GE9, 27.03.14).*

The TCA agreement has worked well to grow a healthy customer-supplier relationship. The factors discussed in this section, trust, open innovation and communication are valued to affect the selection of innovation initiatives strongly by both companies. The section has analysed theoretical arguments stating that these factors can enhance selection principles enabling the selection of viable innovation initiatives. The analysis indicates that this relationship has not facilitated the selection of successful radical solutions. Instead, the TCA has been successful to create a networking platform. The focus has to change towards technology development within both companies to facilitate radical innovations. The foundations for selecting radical innovations exist, but informal networking, interaction and communication between Statoil and GE Oil and Gas has to be directed towards technology development.

6.2.3 Building the business case

Figure 8 presents the business case as an informal factor since it has not yet been formalized into a selection principle on the TCA. It is rather an informal norm to how the companies could engage in innovation selection. Informants from Statoil have given the business case the highest value, and it is seen as a prerequisite for selecting radical innovation initiatives. A top manager in Statoil describes the business case as an enabler for radical innovations: *«How can we facilitate that the (revitalized) TCA foster innovation and great technology steps? By identifying the right business cases – those that are dependent on 'enabling' technologies»» (ST3, 21.02).* Informant ST3 clearly states that radical innovations can be enabled through a common business case drawing on Statoil's need as an innovator (Thoma et al., 2014) and GE's ambitions as a technology leader. This senior associate explains the business case from his perspective:

We have had too many projects that have failed in too poorly defined business cases. The technicians have expressed interest in projects, but we have not managed to identify the business need (…) On that area there is definitely a potential for improvement. (GE7, 28.02.14).

According to informant GE7, selection principles considering innovation initiatives are greatly improved if innovations with technology solving problems for both firms are identified. The theory describes the business case as a separate "Funnel" to consider innovation initiatives in chapter 3.4. The question remains how Statoil and GE Oil and Gas can define a common business case considering innovation initiatives taking care of their common interests.

An informant from GE Oil and Gas describes some challenges they face when they implement innovation initiatives, and how a business case may increase their potential:

The main challenge is to identify a specific business case that is strong enough to implement across business areas and business units in GE. When projects draws on technology across business areas there is a challenge that the projects infers the daily tasks of each employee – you need quite strong drivers to get people to do what it takes (GE9, 27.03.14).

Informant GE9 recognize the obstacles for implementing an innovation project as twofold. The business case needs to be implemented based from a business need and it requires institutional factors providing strength to drive the project through business areas and business units at GE Oil and Gas. The analysis recommends GE to spend resources on formalizing the business case, to emphasize its importance and enable increased use of technologies from other business units on the TCA. This should be a priority to acommodate Statoil's high expectations towards GE of applying technology from other business units.

Summary

- The TCA has established effective and well-functioning informal ties leading to dynamic technology discussions. If both companies utilize the intimate relationship to develop viable innovation initiatives instead of a networking platform, the analysis indicates that the TCA can facilitate radical innovations.

- By spending resources on formalizing the business case as a selection principle, GE Oil and Gas could create separate guidelines to select radical technology based on a common business need. This would strengthen radical innovation initiatives and ease internal innovation collaboration across business units and business areas. If both companies were successful in aligning the formal business case as a principle, it would increase the potential of radical innovations to succeed.

- Approving new technology is a priority for both companies on the TCA. Involving Statoil into the early phases of the Funnel should be a priority for GE Oil and Gas to increase their to receive approval on new technology. This would directly facilitate radical innovation initiatives on the TCA and increase their potential to succeed.

6.3 Formal inter-organizational institutional factors

Only a few formal institutional factors were emphasized to strongly affect innovation selection on the TCA in Figure 8. Furthermore, Statoil and GE had a similar perception of informal factors, while the formal factors can show to vast deviations. One the one hand, formal inter-organizational factors can be more relevant in other phases of the Funnel. On the other hand, misalignement between the intention of the formal factor and the reality to how they affect behaviour can be a reason to these differences. Therefore, this chapter aims to analyse in-depth how institutional factors affect innovation selection.

Certification of technology mainly applies to innovation in the third phase of the Funnel after the technology has gone through testing. Informants may have valued this factor in the interviews because it strongly inter-relates to some of the other institutional factors. Certification of technology can be one way of gaining customer-approval for radical technology.[22] Furthermore, if this factor is improved and valued stronger through the early phases perhaps it would facilitate the selection of radical innovations on the TCA.

6.3.1 The formal TCA design

Obstacles may arise when two companies engage in collaboration. Inter-organizational institutionalism argues that if these obstacles are too vast compared to the output each company receives back they will withdraw from collaboration. Terms and conditions are often subject to negotiation before an innovation is up for screening. NDA[23] and IPR[24] are two contractual clauses integral to regulate how Statoil and GE Oil and Gas interact on the TCA. The idea is that pre-negotiated terms and conditions on the TCA can enable dynamic technology discussions. Both companies regard the formal TCA design as positive for the selection of innovations. Statoil has valued IPR and NDA as factors strongly affecting the choice of innovation initiatives positively in Figure 8. An associate from Statoil explains: *«The TCA encourages experimentation. You know each other well on the TCA, you have good relations and the framework is in place in the sense of IPR and NDA» (ST2, 10.02.14).* Informants share

[22] Referring to the factor «proven» on an inter-organizational level.
[23] NDA: Non Disclosure Agreement
[24]

the perception that IPR and NDA affect the selection decision, but not to the same extent as Statoil. This requires further analysis.

6.3.2 The formal selection principles on the TCA

A formal institutional factor on an inter-organizational level should regulate interaction so both companies receive higher benefits from collaboration than separately[25]. Furthermore, the formal factor should effectively allocate resources across a balanced innovation portfolio with viable radical and incremental projects[26]. Statoil see the steering committee meeting as problematic for innovation and they may regard these formal factors to be a constraint on their internal resources. A mid-level manager in Statoil describes it in this way:

> *You've got some complicated management systems for TCA projects. If you agree with a department manager at GE on a project, then you have to write a paper on the project to receive endorsement from the steering group: Then it goes to the procurement department of both companies. One must go through an additional link (ST5, 26.02.2014).*

Informant ST5 states that the steering committee is a timeconsuming and complicated selection principle. The researcher observed that the steering committee worked as a principle to push innovations forward since this is where they would go through a screening process on the TCA. In the observation, the steering committee affected informants to focus on solving obstacles to innovation due to a forth-coming deadline. The results in Figure 8 and informant ST5 indicates that the steering committee is a vast challenge to facilitate radical innovations due to stringent routines that may lead to loss of balance in the portfolio[27].

GE's employees do not regard the steering committee meetings to affect innovation selection substantially. The steering committees are describes as integral to manage innovation initiatives. It is a selection principle directly used to select innovations. Furthermore, the steering committee is responsible for value creation on the TCA and it consists of the top-level management in Statoil and GE Oil and Gas. It is a extremely challenging to innovation selection that formal selection principles cannot identify viable innovation initiatives. According to the

[25] According to the institutional arguments on an inter-organizational level.
[26] According to the theoretical arguments presented on PPM.
[27] Since none radical innovation initiatives have been introduced by GE Oil and Gas in the last six years, it is presumed that they have not been developed on the TCA either.

literature on PPM, formal management tools in the early phases of the Funnel should not be too stringent and they should reduce risk. The DARPA model presented in chapter 3.5 have a similar objective as the TCA: conducting radical innovations on a short time scope with participation of talented people. The DARPA model has been successful by using temporary teams with highly skilled collaborators. Perhaps, the steering committee meeting can incorporate some of the methods used at DARPA and enhancing the incentives for innovation collaboration instead of an impediment. On the one hand, changing single members of the steering committees may lead to imrpoved innovation initiatives. On the other hand, the steering committee drives innovations forward. Consequently, a selection principle with a similar function to the steering committee can enable progress in innovation initiatives, but the routines this factor creates needs to be improved to facilitate the selection of radical innovations.

The T-session is considered to be helpful, but neither Statoil nor GE have valued this as a selection principle strongly affecting innovation selection according to Figure 8. The informants explains that they have attended several of these events, without leveraging substantial accomplishments.

The steering committee meetings and the T-session are formal factors that have demanded vast resources without providing the expected results. From improvement, they could affect the selection of innovation initiatives stronger. This argument is especially relevant for radical innovations where innovation selection becomes increasingly difficult, and the selection of promising ideas is even more challenging. The use of stringent tools involves the loss of flexibility, a vast challenge to facilitate radical innovations on the TCA according to the analysis in section 6.1.1. Consequently, new selection principles used to select innovation initiatives can give better results and enhance potential ROI of the innovation portfolio.

6.3.3 GE delivering on time

Theory introduced in chapter 3.4 says that time-consuming innovation projects can lead to economic decline if innovations fail and this means waste of resources and high costs. Accordingly delivering on time is closely associated to risk, which is a vast challenge to facilitate radical innovations.

In Figure 8, GE's incapability to deliver innovation projects on time has been valued negatively by Statoil. Informants from GE does not share Statoils perception to the same extent. Innovation projects are time-consuming and if one of the parties fail to deliver, risk increases and imposes higher resource constrains for the other party[28]. Furthermore, If projects are unable to keep reasonable time scope they may become more costly and resource demanding. For Statoil, who are currently cutting costs, this may be an obstacle to innovation collaboration. Neo institutionalism claims that companies stop engaging in collaboration with other companies when the constraints are higher than the benefits. An informant from Statoil describes it like this:

> *When we collaborated with Wellstream before they became a part of GE, everything used to be quick and easy. Now, however, they have competency in a scope that they did not have before. We have experienced this on a project that we tried to implement on condition monitoring. There are many people involved in the project that we have to relate to. At the same time, too many cooks spoil the broth. It takes time and everybody has to agree on something that is agreeable for everyone: GRC in Niscayuna, GE in Norway and GE in Newcastle (ST5, 26.02.2014).*

Informant ST5 understands that quick decisions can be difficult to implement in a large organization like GE. At the same time, he expresses this to be frustrating. Informants from GE Oil and Gas value their ability to deliver on time slightly positive on the TCA. This informant from GE Oil and Gas describes one of the reasons why:

> *I think the TCA shortens the time in the upfront evaluation. The TCA surface the right projects and allow for a quickly evaluation on management levels and allow the project to move forward because we have many of the currents pre-negotiated versus negotiating over and over again within each project (GE15, 10.04.14).*

Informant GE15 emphasize a positive relationship between pre-negotiated contractual clauses on the TCA and GE's ability to deliver on time. The researcher observed that GE Oil and Gas did not manage to deliver everything they had agreed in an innovation project with Statoil. When Statoil remarked this, the researcher found under the next observation that GE Oil and Gas had taken care of the request. GE's inability of delivering on time needs to be analysed further in the intra-organizational analysis since this matter concerns how GE Oil and Gas develop innovation initiatives internally.

[28] According to literature on PPM presented in chapter 3.4.

Summary

The analysis on formal inter-organizational factors, written rules regulating how two companies interact, have indicated some interesting propositions:

- The pre-negotiated terms and conditions on the TCA enhances technology collaboration.

- The formal selection principles, the steering committees and workshops, are hindering the selection of innovation initiatives on the TCA. Formal factors regulating innovation collaboration have been time-consuming, resource demanding and have proven poor results. Statoil see these selection principles particularly challenging to facilitate radical innovations. The analysis indicates that the steering committee needs to be improved yielding better results, if not the companies may withdraw from innovation collaboration in this form.

- The formal factors have led to a collaboration climate where every informal factor are valued to strongly affect innovation selection. This leads to a suggestion that changing and improving some of the formal factors may facilitate the selection of radical innovation initiatives on the TCA.

- GE’s inability to deliver on time needs to be improved. The analysis indicates that this requires a further examination on the intra-organizational level.

6.4 Informal Intra-organizational analysis

Until now, the TCA analysis has indicated that many answers to how selection principles can facilitate radical innovations are found on the intra-organizational level at GE Oil and Gas. Furthermore, Figure 9 demonstrates intra-organizational factors to have a lower value compared to inter-organizational factors by informants from GE. In this level, informal factors are valued to affect the selection of radical initiatives stronger than formal factors. Figure 9 implies that mainly formal factors are valued to negatively affect innovation selection. There seems to be a lot of improvement to how formal institutional factors affect innovation management. Figure 9 presents informal intra-organizational factors above the blue line and formal factors beneath the blue line. The values have been calculated likewise the values presented in Figure 8, and presents the average score of informants from GE Oil and Gas.

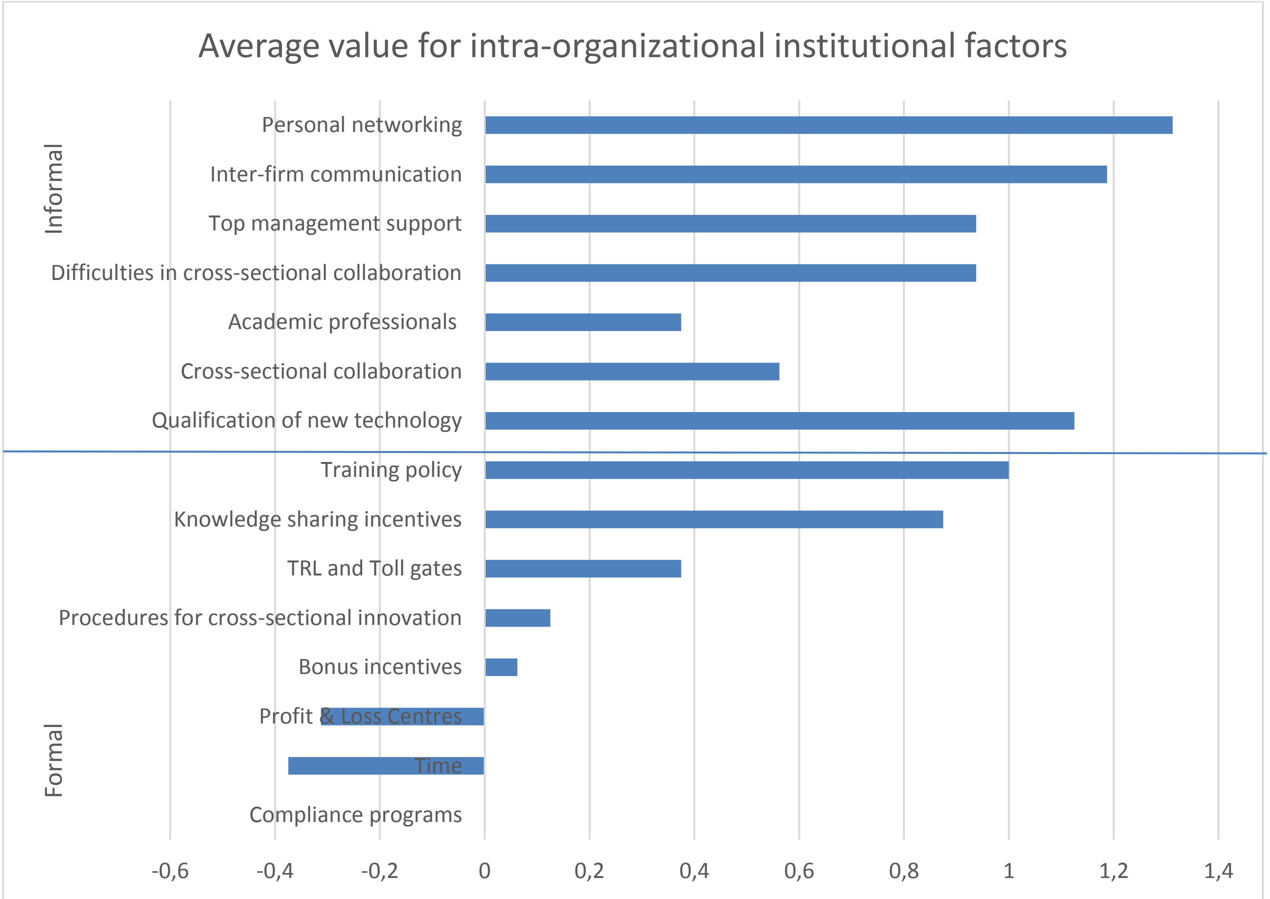

Figure 9: Intra-organizational factors at GE affecting innovation selection.

6.4.1 Top management support from the CEO

Institutionalism says the empowered entity in question can create institutional factors and give them meaning. The top management in a company can establish intra-organizational institutional factors and assert them with a meaning, for instance an internal norm implying that each employee who works overtime is a hard worker. The TCA has received top-management support from both companies which can crucial to encourage the decision maker to take risks and experiment in the selection of innovation initatives.

A top manager at GE describes CEO Jeff Immelt's view on technology development with Statoil: *«Jeff Immelt said he wanted a couple of super technologies with Statoil. Statoil's management also wants to achieve something grand» (GE9, 27.03.14).* Informant GE9 implies that Jeff Immelt wants breakthrough technologies to be developed on the TCA. Furthermore, in the last year GE's top management has introduced measures to show their support to the TCA. A top manager in GE underscores one informal mechanism:

Last year, six oil companies were chosen by GE as Corporate Strategic Accounts. This has significantly increased the focus on Statoil among stakeholders on all levels in the organisation. Jeff Immelt has 15 Strategic Accounts across the entire GE corporate. Statoil was chosen from a potential of becoming a technology leader. They are not our biggest customers, however (GE9, 27.03.14).

Informant GE9 clearly states that GE's top-management recognize Statoil as an important customer. Institutionalism claims this to be a powerful factor enhancing commitment to fulfil the TCA's unresolved potential and deliver profitable radical solutions with technology from a competing path. At the same time, the top management is pressing for radical innovation initiatives and have perhaps not succeeded in leveraging this understanding through the entire organization given the scarce results on the TCA and the difficulties innovation initatives have encountered internally at GE. Institutionalism indicates that professionals within the organization have a jurisdiction to change the working logic of an institutional factor. The next paragraph will analyse this factor.

6.4.2 Professionals with an academic education in a position of power

Intra-organizational institutionalism asserts that professional employees with an academic background possessing a distinct jurisdiction are in a special position to shape the implementation of formal institutional factors into the organization. According to Figure 9, they affect innovation collaboration between Statoil and GE Oil and Gas. This analysis redeems to figure out which professionals, how they affect innovation selection and why.

Several informants have indicated that specific professions within GE complicate innovation projects on the TCA. Five informants, four from GE Oil and Gas and one from Statoil, have valued professionals with an academic background to strongly affect the selection of innovation initiatives. A top manager expresses his view:

GE has a reputation of being "difficult" to work with in negotiations of legal and commercial T&C's. Lawyers and commercial managers in the different businesses have not been aligned and we have "overwhelmed" customers with comments to their contract proposals. For Statoil we have now developed a tool and a process to ensure alignment and "un-necessary "commenting" going forward (GE9, 27.03.14).

Informant GE9 indicates that professionals directly affect innovation projects on the TCA. At the same time, he points to communication as a means for dealing with this challenge. Despite pre-negotiated contractual clauses settled beforehand, a practice of time-consuming discussions of legal terms and conditions exist. After these dynamic discussions, some informants perceive the time it takes to process legal matters by academic professionals working in the legal department as a hindrance for the selection and implementation of radical innovations. The informants are divided two to three regarding howlegal professionals affect the selection decision positively or negatively. A senior associate, however, describes the academic employees as the biggest bottleneck to collaborate across business units on innovation projects:

> *Can we utilize technology other business units are developing? Well, then they would have to look at their agreements – and that is not easy. It is not easy to take projects on a short notice, many things have to be dealt with, especially not violating any legal agreements (…) Reaching an agreement is tiresome and time-consuming. It is the biggest bottleneck (GE7, 28.02.14).*

On the one hand, it is crucial for GE not to violate terms and conditions on the TCA because legal they leverage GE's commercial viability. This may be the reason why three informants from GE have valued the academic professionals as an important factor in the selection of the innovations. At the same time, the lack of flexibility and the challenge these professionals have on settling agreements is a vast difficulty to facilitate radical innovations. Consequently, it is concluded that legal practices within GE is strongly affecting the selection of radical innovations on the TCA. Furthermore, to some extent they are also a challenge to succeed with radical innovations.

6.4.3 Cross-sectional collaboration and inter-company communication

This section analyses how cross-sectional collaboration affects innovation selection. The ability to perform innovation initatives across business units was expressed by Statoil as one of the main reasons to engage in a TCA with GE Oil and Gas. Furthermore, the section analyses how inter-company communication and personal networking affects innovation collaboration. The possibility to draw on technology from multiple areas is one the benefits GE have compared to many competitors in the oil and gas sector.

Cross-sectional collaboration and difficulties in cross-sectional collaboration emerged as distinct patters in the collection of data and the proposition that these factors strongly affect the selection of innovations at GE Oil and Gas can largely be verified. Cross-sectional collaboration have been given two contradictory normative meanings by informants on the TCA. Furthermore, Cross-sectional collaboration enhances innovation initiatives and facilitate radical innovations because disparities in knowledge, competency and technology are healthy to foster radical innovations. This abundance of knowledge counters challenges to innovation selection according to open innovation theory. A senior employee at GE Oil and Gas describes his experience from cross-sectional collaboration; *«It is not easy to find the right person on innovation initiatives across business units, and one is dependent on a personal network. I think the latter is very important» (GE7, 28.02.14).* That GE7 engage in informal collaboration across business units can enable identification of viable innovation initiatives. Difficulties expressed by GE7 has is a barrier to cross-sectional collaboration.

Another informant from GE Oil and Gas emphasize that GE is a very large organization and that personal networking often is the most efficient way of finding the right people to engage in collaboration with (GE17, 11.03.14). In addition, informant GE5 explained in the interview (5.03.14) that no formal routines for identifying collaboration partners exist and therefore a lot of collaboration transpire from informal networks. GRC has appointed a Business Program Manager (BPM) to manage cross-sectional collaboration at GE through formal and informal factors. The BPM is applied to establish a contact point between GRC and the business units. An informant describes the BPM position in this way:

> *The job of a BPM is not to create a bottleneck and centralize all the communication through himself, but rather find and connect the right people at GE Oil and Gas and GRC that can then create their own channels of communication. You can formalize it much more, and we have tried that as well: The experience is that formalization and centralization of the communication is not the way it works (GRC8, 18.02.14).*

Figure 9 indicates that the BPM has managed to create informal ties for cross-sectional collaboration, however these ties have not overcome the vast difficulties to engage in cross-sectional collaboration at GE. GRC have talented scientinsts working at their research facilities and have launched several radical innovations on other business areas. Increasing their involvement could be benefical to facilitate radical innovations. An informant shares his experience from cross-sectional collaboration:

"We have common procedures within Oil and Gas that enable collaboration(...) It is natural for us to communicate directly with other business areas within the GE Oil and Gas business unit since we have many common interfaces and they are near us organizationally"(GE3, 27.02.14).

Informant GE3 indicates that cross-sectional collaboration works well for business areas at the oil and gas business unit where communication occurs naturally from intensive interactions. The analysis suggests that it can be difficult for GE Oil and Gas to facilitate successful innovation initiatives when the project draws on competency from other business units. Furthermore, the links towards GRC should provide increased expertice on radical technology with a high potential to succeed. The analysis suggests that difficulties in cross-sectional collaboration arises when innovation collaboration is performed across business units.

The theory on intra-organizational institutionalism emphasizes that informal factors may be crucial to achieve good performance on innovation projects. According to Figure 9, employees at GE values inter-company communication and personal networking to affect the selection of innovations highly. Communication skills seems to be extremely important when cross-sectional collaboration is conducted on innovation projects:"*You need to be a good communicator and an influential leader to ensure that someone who does not report to you still can make something you need happen" (GRC8, 18.02.14).* Informant GRC8 underscores communication to be a drive for efficient cross-sectional collaboration. This chapter can conclude, however, that the informal institutional factors for cross-sectional collaboration are well functioning, yet insufficient in enabling GE Oil and Gas to meet the objectives of the TCA.

Summary

- The top management has recently imposed measures (which?) to enhance the importance of innovation initiatives on the TCA. The analysis implies that this has not been aligned throughout GE's organization since vast difficulties to cross-sectional collaboration still exists.

- Cross-sectional collaboration is integral to meet the objective of using technology from other business units at GE. It can facilitate the selection of radical innovations and at the same time increase the potential of GE's innovation portfolio. Cross-sectional collaboration seems to work well within the Oil and Gas business unit, but vast difficulties occurs when employees engage in collaboration with other business units.

- Time-consuming negotiations conducted by professional employees working with legal terms and conditions are a bottleneck for innovation.

- Despite the high value score of informal factors, the TCA is unable to develop successful radical innovations. The chapter has addressed formal institutional factors as the main challenge for innovation selection.

6.5 Formal intra-organizational factors

A manager or the corporate management can create formal procedures or routines that employees have to follow. This section analyses how formal factors at GE affect the selection of innovation initiatives and if they facilitate the selection of radical innovation initiatives. According to Figure 9, informants from GE have given these factors very different value scores to how they affect innovation selection.

6.5.1 Formal factors inducing selection of viable innovation initatives

Qualifying technology has the highest value score of formal intra-organizational factors in Figure 9 and it inter-relates to many institutional factors (e.g. the business case, proven and TRL-level). Qualifying technology is an internal procedure often involving customer participation. The associate from Statoil accounts for this:

> *When it comes to technology development (…) it is currently more important for us to get the same output at a lower cost than higher output but at a higher price. An overall assessment of cost versus benefits will decide if we go for a new solution and the technology must be qualified before it can be taken into use (ST2, 10.02.14).*

Informant ST2 emphasize that for Statoil, qualification reduces the risk of pooling resources on innovation without receiving ROI. Companies use the TRL-scale to assess the technological readiness level of a new solution. An employee in GE Oil and Gas refers to TRL-level in this manner:

For Statoil, a solution is proven[29] *when it reaches TRL level four*[30]*. It does not have to be field proven, but the solution has to go through a sequence of qualifications and tests. A standard exist to regulate qualifications and tests in order for the equipment to reach this level (GE13, 27.03.14).*

Informant GE13 clearly states that Statoil relies on a number of institutional factors (e.g. standards, tests and qualifications) to assess if new technology is ready for use. This underscores the strong value asserted to qualify new technology affecting the selection of innovation initiatives at GE Oil and Gas positively. According to institutionalism, it can be critical that employees engage in qualifying technology to facilitate the selection of radical innovations, if not this institutional factor that is crucial for innovation loses its significance. Involving the customer from early phases innovation and engaging them into qualification may increase the potential to succeed with radical technology.

Institutionalism says that internal procedures can enable employees to engage in cross-sectional collaboration if they are influencing their behaviour. In Figure 9, "Formal procedures for innovation collaboration" has a low value and does not affect innovation selection. The BPM is for instance a formal procedure for innovation collaboration (In addition to the facilitator of informal connections) and a contact point for employees at GE Oil and Gas to gain knowledge on technology developed elsewhere in the organization. A senior associate describes this function: «*I use the BPM as a connection point to other business units. I go to the BPM for Oil and Gas and I ask him if GRC has performed any research on this area. How this works has been depending on the person in the position." (GE7, 28.02.14).* Informant GE7 stresses that the BPM can be increasingly helpful for driving technology enquiries and establishing cross-sectional collaboration.

According to institutionalism, a lack of formal routines to facilitate fast integrations where effective cross-sectional collaboration runs efficiently hinders GE's performance to meet the TCA objectives. The analysis emphasize the importance of qualifying technology, TRL-levels and formal procedures for the selection of innovation initiatives. These factors seems to be especially critical to facilitate radical innovation initiatives. Through improvement they can facilitate innovation initiatives with a higher potential to succeed.

[29] The citation refers to "proven" as an institutional factor.
[30] An overview of the TRL scale is presented in the appendix.

6.5.2 Knowledge Sharing Incentives and Training Policy

In Figure 9, GE's employees value their training policy highly. One employee describes GE's training policy:

> *GE has an excellent training policy. You are not expected to transfer from technical work to manager work without support or training. The training involve courses on communication, coaching, mentoring and so on. It is extremely valuable (GE14, 28.03.14).*

Informant GE14 has experienced that GE's training policy is working well. GE offers courses so that employees can enhance their knowledge on areas outside of their core expertise. Furthermore, training their employees in soft skills alike communication is an objective with internal courses (GRC8, 07.02.14). According to literature on innovation management, organizational learning and the exposure of employees to external knowledge flows[31] increases the ability of strategic decision making enabling selection of viable innovation initiatives. There is still a lot of improvement to enhance how knowledge sharing incentives and training policy affects GE's innovation performance on the TCA. An associate at GE Oil and Gas describes how GRC facilitate viable knowledge sharing activities:

> *GRC organize internal conferences where they present their own technology. GRC is very skilled at reaching out to the different business units and presenting their work (...) The is responsible of transferring knowledge of technology between GRC and GE Oil and Gas (GE11, 10.03.14).*

Informant GE11 suggests that when the employees take GE's formal routines on knowledge sharing and training policies into action, they are well functioning. These factors enable the selection of radical innovations and can increase their potential to succeed. Furthermore, the two formal factors discussed in this section are well-functioning and not the reason why the TCA has been unsuccessful to develop innovation projects based on radical technology.

6.5.3 Factors without an effect

Figure 9 presents compliance programs and bonus incentives[32] as formal institutional factors not emphasized to affect innovation selection. The theory on PPM acknowledge financial

[31] Refers to open innovation presented in section 3.2.1.
[32] See Figure 9 presenting the values from the interviews.

reward incentives to motivate employees to take risks facilitating radical innovations. None of the informants appointed the bonus-system to be a specific goal enhancing radical innovations*: "What I am basically saying: We do not have a direct bonus system that rewards risk, we have opportunities to reward risk that are left to the individual criteria of managers" (GRC8, 18.02.14).* Consequently, the current bonus system does not seem to affect the selection of innovations on the TCA.

Compliance programs are internal programs and policy decisions a company makes in order to meet the standards set by government laws and regulations. According to macro institutionalism, companies can reduce institutional risks in areas with unstable and unpredictable institutions by spending resources on these programs. In Figure 9 they are not valued to affect the selection of innovation initiatives at all, perhaps they are more important in other parts of the Funnel. Consequently, the analysis can approve on the results in Figure 9 where these factors are not affecting innovation selection at GE Oil and Gas.

6.5.4 Formal factors affecting innovation selection negatively

The inability of GE to deliver on time was emphasized as a factor that needed further analysis in the section discussing inter-organizational factors. Statoil emphasized that intra-organizational time-consuming routines and GE's inability to come up with quick responses obstructed innovation initiatives on the TCA. An informant describes how time has affected innovation projects on the TCA on the intra-organizational level:

> *What we have discussed a lot with GE is that things take time. They haven't been very coordinated internally (...) There are units that are overloaded in work, especially on the legal aspect, that affects things to take a lot of time (ST2, 10.02.14).*

Time-consuming routines to process legal matters have been a common characteristic to institutional factors affecting innovation selection of the TCA. When things take too much time, the momentum after the dynamic technology discussions is lost and this has been a bottleneck to succeed with innovation projects.

The technology discussions are working well, the formal layout of the agreement is well embedded in both companies, but when the innovation projects aims to draw on technology from other business units internally at GE Oil and Gas- it takes to much time and it becomes increasingly difficult to deliver on schedule. An informant from GE describes innovation collaboration in this way: *Innovation collaboration across business units does not happen very often, when they do however, they seem to be very challenging because each business area is managed under a separate Profit and Loss Centre (P&L) (GE5, 06.03.14).*

Informant GE5 suggests Profit & Loss Centers to challenge intra-organizational innovation collaboration. The informant implies that each business area have their own Profit & Loss budget and that cross-sectional collaboration interferes with the everyday working logic of employees at GE. The theory says that this working logic can easily be changed by an entity of power if the institutional factor is aligned through the organizational. The analysis reveals that P&L's are a challenge for innovation collaboration across several business areas. The motive may be that the individual cannot see how his business area gains when another P&L will get the majority of ROI when the project is successful. The analysis has found that informal factors align the importance of a decision to affect the work logic performed by employees within an organization. Consequently, the poor relation of P&L's and time regarding the selection of innovation initiatives at GE can be improved through communication and increased interaction.

Summary

- The analysis suggests that GE should involve Statoil into the early phases to enable qualification of new technology. This may facilitate radical technology since Statoil, the customer, is already committed to innovation through the TCA.

- GE's internal training policy and knowledge-sharing activities are well functioning and possess the quality needed to facilitate radical innovations.

- Despite GE's focus of being a "technology leader", most formal intra-organizational factors are not encouraging innovation – instead they are hindering the selection of innovation initiatives. "Toll-gates" and the BPM is insufficient to enable cross-sectional innovation and achieve the potential GE Oil and Gas has to facilitate radical innovations.

- Time and P&L's have an undesirable effect for innovation initiatives on the TCA. Time inter-relates to academic professionals, late delivery of equipment and time-consuming cross-sectional collaboration that has vast resource constraints internally at GE.

- The analysis has found that the bottle necks for the selection of innovation initiatives lies internally at GE Oil and Gas. Perhaps revitalized selection principles can improve the results with successful innovation initiatives on the TCA.

7 Gas discovery in Tanzania

This case study analyses how GE Oil and Gas prepares for a future delivery of advanced technical equipment to Statoil concerning exploration of gas in Tanzania. The case study analyses how innovation challenges and macro institutional factors will affect the selection of innovation initiatives to a developing country with high institutional risk. In addition, this is the first time GE Oil and Gas will deliver equipment to Tanzania. How does GE Oil and Gas perform the selection of innovations in this context? Furthermore, will this project facilitate radical innovations and can it increase the potential of the innovation portfolio?

No formal agreement has been signed between GE Oil and Gas and Statoil for this delivery. If Statoil takes a final decision to carry on with the project, they are going to need technical equipment for an offshore installation plant and an onshore processing facility in Tanzania. Statoil does not require the use of radical technology for this project, and are only looking for a buyer before initiating the final decision whether or not to carry out a full-scale gas exploration project (Blas, 2013)

Statoil is an International Oil Company (IOC) owned 67% by the Norwegian state claiming to use local content as a commercial principle. If Statoil as an operating agent takes a clear stand to comply with local laws and regulations in Tanzania, GE Oil and Gas would follow their lead[33]. Statoil has become an experienced exploration agent of oil and gas with an international presence in more than 27 countries. Unfamiliarity with institutions on a macro level leads to increased risk to introduce innovation into the market according to institutionalism. Local governments may impose laws and regulations for the operating oil company to use technology reducing CO_2 emissions or set strict demands to build local content in order to receive a social license to operate. Companies reduce institutional risks through compliance and creation of local content (PFC Energy, 2013). If the local population do not benefit from extraction of oil and gas social unrest and local opposition can arise, like in Congo and Nigeria for instance (Fouche and Koranyi, 2013).

Statoil has discovered natural gas in reservoirs located on very deep waters, between 2300 and 2600 meters in depth. The technical challenges offshore involves engaging in a subsea environment with high pressure and low temperatures, which in turn can lead to the formation

[33] See citation of GE1 on page 41.

of hydrates in the pipeline. This is a vast challenge to gas exploration since hydrates can lead to clogging of the pipeline and potential environmental disaster (Helgesen, 2013). The reservoirs are located 100 km offshore complicating the transport of gas to a processing plant onshore. Only a decade ago, this exploration was considered impossible. The uncertainty is related to how the underlying water, called aquifers, and the risk of water production will affect exploration. The field has an estimated recovery rate from 60 to 80 percent recognized as one of the in its best class. This will be the deepest gas discovery to this day and advanced technical equipment will be placed on great depths. The technical risks with this project can be solved with current technology (Helgesen 2013), but qualifying this equipment to prevent gas leaks on deep oceans becomes increasingly important.

Tanzania is crucial for Statoil because it represents its most promising investment opportunity to engage in development of natural gas outside of Norway (PFC Energy 2013). For Statoil it is important to explore natural gas to offer “clean” fossil fuels as an alternative to renewables in the future energy landscape. For both companies this project represents an opportunity to use concepts from the competing technology path if radical technology can be developed to reduce CO_2 emissions and exploration costs to a minimum.

The plan is to process natural gas in an LNG plant placed onshore Tanzania together with another oil company, BG Group. The process facility will apply technology to compress natural gas into liquefied natural gas (LNG), enabling export to markets in Asia. Institutional factors on a macro level, both formal and informal, are forecasted to play a crucial role in Tanzania. Especially the upcoming elections in October and the current revision of the gas act may be a challenge. The large gas discoveries over the past two years have brought the country to revise its national oil and gas policy. Norwegian government officials in NPD and MOPE are assisting the Tanzanian government with this job (OD1, 19.02.14). In addition, local opposition to both the regional and global export of natural resources has resulted in recent violent clashes. BG Group has therefore announced that the project may progress slower than anticipated. In addition, economic challenges remain and the new industry demands an infrastructure that is not yet in place. It creates safety risks and additional costs for security (PFC Energy, 2013).

7.1 Innovation challenges: Path dependency, lock-in, lockout, inertia and NIH-syndrome

Path dependency evolves from previous experience and can affect the decisions a firm makes[34]. Accordingly, the possibilities of path dependency to challenge the innovations GE Oil and Gas will offer and perhaps utilize are seemingly low because the company has never conducted business in Tanzania before. An associate in GE Oil and Gas explains the situation:

> *All experience used in Mozambique will be used for our go-to-market plan in Tanzania. We will maybe use the same high-level strategies, but from a tactical point of view, obviously it is different (...) There is a difference in maturity in how those countries can exploit their oil and gas resources (...) and maybe expanding that question for East-Africa to West Africa. We have a lot of experience from Angola and Nigeria that we can leverage for Tanzania (GE4, 07.02.14).*

Informant GE4 implies that GE Oil and Gas is considering several strategies when they are going into a country where they have never conducted business before. Hence they do not have previous experience to develop path dependent behaviour from. At the same time the company is operating in the region and have the opportunity to build expertise on experience from other markets. Furthermore, absence of path dependency to leverage experience for this project may be a challenge for technology development. Statoil has not yet taken a final decision to go through with the project or not. Therefore, the analysis of path dependency is only plausible for this case study. The reinforcing effects of path-dependency, lock-in, lockout and NIH-syndrome, can only be analysed after Statoil's final decision and are excluded from this case study.

Technical installations offshore do not require radical innovations, but Statoil indicates that incremental innovation to existing equipment is necessary. A mid-level manager at GE Oil and Gas describes his view regarding implementation of radical technology in Tanzania:

> *The only thing that can lead to a technical leap is a solution leading to cost reduction and that increases the value of the field. If you can find a completely new solution which saves for instance a platform… the Subseafactory[35] is a radical solution in this sense, and some elements of it has already been qualified for use (GE1, 18.02.14).*

[34] Path dependency is explained in chapter 3.1.
[35] A subsea factory is a process plant on the seabed making it possible to utilise remote-controlled transport of hydrocarbons at any offshore facility STATOIL. 2014. *The subsea factory* [Online]. Available: http://www.statoil.com/en/technologyinnovation/fielddevelopment/aboutsubsea/pages/lengre%20dypere%20kaldere.aspx..

Informant GE1 does not exclude opportunities for radical innovations in Tanzania, but he emphasizes qualification of innovations as a necessity to enable successful introduction of a radical solution. Qualifying new technology is resource demanding and requires the consent and participation of a customer – Statoil in this case, where 57% of the informants have valued their organization to be path-dependent. Furthermore, informant GE14 emphasizes on page 38 that utilizing radical solutions offshore have become increasingly difficult after the Macondo accident in 2010. In Figure 4, path dependency is considered as the greatest challenge to the selection of innovations. Furthermore, the industry is pressured to develop cost-effective solutions for offshore operations. The analysis suggests that path-dependency will probably lead Statoil to decide to use a current technology if they go through with the exploration of gas in Tanzania. In addition, the analysis implies that this may obstruct Statoil or GE Oil and Gas to develop technology that can be applied in the new energy landscape, since this technology is not costly sustainable or environmental friendly compared to future requirements. However, it is too soon to tell if path dependency will affect the selection decision strongly.

Statoil and GE Oil and Gas seem to express inertia towards the application of solutions in the competing technology path. According to Figure 6, both Statoil and GE Oil and Gas indicate lower values on inertia than other informants. Informant GE1 implies that the subsea factory is a radical solution currently under development that can replace a platform requiring new infrastructure. At the same time, Statoil does not recognize a demand for radical innovations because sufficient technologies already exist both onshore and offshore. If the supplier recognize a problem they can use radical technology to solve, the supplier can use the business case, fast tracks and open innovation as selection principles to convince Statoil to share the risks of engaging in innovation initiatives. Consequently, the analysis assumes that path dependency and inertia are challenges to choose viable selection innovation initiatives in Tanzania. The analysis has identidied tools from the theory to counter some of these challenges. A final decision is not yet taken and the subsea factory is only tests and qualifications from usage. The next part of the analysis will examine the remaining factors from Figure 4; flexibility, risk taking and experimentation – which are identified to facilitate the selection of radical innovation initiatives.

7.1.1 Flexibility, risk taking and experimentation

Figure 7 indicates that GE Oil and Gas has a higher value regarding experimentation and risk-taking than Statoil. Statoil, the customer and the operator, has lower values and at the same time higher responsibilities associated to extraction of gas in Tanzania. A senior associate at GE Oil and Gas comments some of the problems associated to use of equipment with a risk of technical failure:

> *A common problem is to introduce something completely new to a subsea development. One issue is that a system failure or similar may have an effect on overall production, even if qualifications have been undertaken. An example could be for a "remote location" with limited onshore facilities and/or infrastructure; The concern is, what if something happens or what if something is not working as intended even if tested and qualified for use. This may impact the field development or the production (GE2, 10.03.2014).*

The informant demonstrates a number of practical and well-defined reasons for not taking risks offshore in Tanzania. Taking risks and experimenting in Figure 7 does not seem to affect the selection of innovation initiatives at GE Oil and Gas greatly. For Statoil, collaborating with GE Oil and Gas seems to be beneficial in order to reduce risk and gain access to knowledge and competency they do not have themselves. Engaging in a partnership may facilitate radical innovations enabling the companies to consider innovation initatives through a different lense, identify new business needs and reduce the risk of failure[36]. It is too early to conclude which technical solutions Statoil will use in Tanzania. The unwillingness to take risk and experiment has a potential of becoming a challenge for innovation selection in each company individually, but in an innovation collaboration, these challenges are defied.

The theory on institutionalism acknowledge that companies that adapt to environmental conditions and integrate these efficiently into the organization develop more successful innovations. PPM suggests management tools to handle these changes and ensuring flexibility as a necessity to facilitate radical innovations. In Figure 7 GE Oil and Gas has a lower flexibility score than Statoil. Consequently, the lack of flexibility can be a challenge to the selection of innovations for GE Oil and Gas in this case. In the interview with GE4, he expresses that innovation and how the business in a new country is built does not necessarily relate to innovation at GE Oil and Gas (GE4, 08.02.14). The analysis indicates that flexibility and fast iterations where external environmental conditions are quickly integrated into the internal

[36] According to the literature on open innovation and inter-organizational institutionalism, as well as PPM.

organization of GE Oil and Gas have the potential of challenging the selection of innovation initiatives intended for Tanzania. At the same time, it is difficult to judge at this stage what will happen down the road. No formal agreements have been signed and the risks of starting the process of developing radical technology seem to be too high for the moment. Furthermore, when Statoil makes the final call to invest in a full-scale gas exploration project in Tanzania the innovation challenges discussed in this chapter will be largely reduced.

Summary

- Radical solutions exist and can be taken into use in Tanzania. The analysis reveals that path-dependent behavior from resource constraints are a challenge to innovation selection. Inertia in the oil and gas sector after the Macondo accident is a vast challenge to select and succeed with radical technology. Consequently, this project does not seem to facilitate radical innovations.

- The risks of implementing radical technology in Tanzania are higher than the benefits they would give compared to existing technology. The lack of flexibility at GE Oil and Gas to integrate new environmental conditions in Tanzania quick and efficiently is a challenge to succeed with innovation initiatives when entering a new country. Accordingly, GE Oil and Gas should focus establishing formal and informal routines to enhance adaptability and to reduce the risks of failing with technology introduction.

7.2 Macro Institutional Challenges

The research question proposes that macro institutional factors strongly affect selection of innovations in Tanzania. This statement has a strong theoretical foundation in macro institutional theory. Figure 10 presents an overview of all macro institutional factors derived from interviews with 38 informants. Formal institutional factors are dark blue, and informal institutional factors have a light blue color. Figure 10 demonstrates that several macro institutional factors are valued highly of the informants to affect innovation and technology development in the oil and gas sector.

Figure 11 presents an overview of informants from GE Oil and Gas who mentioned one of all the macro institutional factors to affect innovation selection during the interview. The factors above the blue line are informal factors, and the factors below the blue line are formal factors. Figure 11 shows clear distinctions from Figure 10. Of the nine informants at GE Oil and Gas who mentioned macro institutional factors, local conditions were emphasized to heavily affect technology development. None of the informants described public perception or time to affect the selection decision. Therefore, it will be interesting to see if the proposition adheres to the results revealed in the following analysis.

Macro inst. Factor	Percentage
Laws	61,1 %
Regulations	58,3 %
Local Conditions	44,4 %
corruption	33,3 %
Agreements	30,6 %
Forum	30,6 %
Creating Local content	29,6 %
Time	27,8 %
Public perception	22,2 %
Communication with the local community	8,3 %

Figure 10: Percentage overview of macro institutional factors valued by the informants.

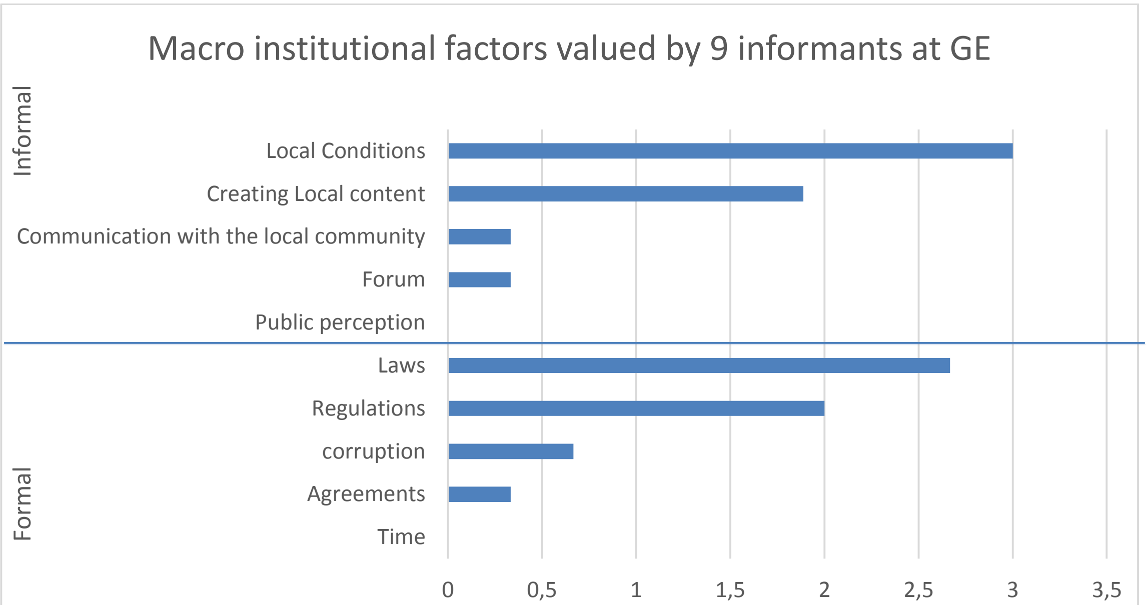

Figure 11: Average value score for 9 GE employees who mentioned macro institutional factors in the interview.

7.2.1 Local conditions

Local conditions refers in Tanzania creates issues relating to involving a population with low human development, high socioeconomic challenges and difficulties in executing and maintaining a stable legal and judiciary system (Fouche and Koranyi, 2013). Exploration of fossil fuels in Tanzania requires Statoil to commit to a country over a long period. Their investments are therefore vulnerable to abrupt changes in local conditions. According to macro institutional literature, local conditions can strongly affect the outcome of an engineering project in the natural resource industry. Increased knowledge on local conditions may indicate which projects GE Oil and Gas should choose to allocate their resources on.

If Statoil decides to go through with the operation in Tanzania, they can expect to remain in the country for 35 - 40 years (ST7, 02.05.14). For equipment suppliers, this impose a requirement of a local presence to complete service and maintenance on request. Therefore, local conditions have proven to affect ROI on technical installations strongly, and this has been the case for other oil and gas companies operating in Africa as well (Fouche and Koranyi, 2013). An informant from INTSOK expresses his view about the matter:

The oil and gas sector is far from labor incentive and will only require a limited number of employees. Local conditions will not be particularly important for the oil companies because they work offshore and the employees onshore will be mainly highly qualified staff. (…)The onshore facilities will be operational for decades to come and the locals will therefore increasingly see the benefits. Initially the people outside of the fence will be wondering if they will benefit from the exploration at al. They will, but they will need to be patient (IN1, 07.02.14).

Informant IN1 indicates that Statoil's operation in Tanzania will not be affected by poor local conditions because exploration of gas is carried out offshore or behind a fence protected from the local conditions. According to informant ST1 on page 40, Statoil was responsible of introducing a business model where local companies became involved in technology development through re-educating and retraining. The informant describes it as the single radical innovation Statoil has introduced, and the question remains if they would do the same in Tanzania, a country with poor local conditions. In addition, informant IN1 implies that Tanzanias population will wonder when they can gain gas exploration, and managing their expectations (Olsen 2014) is one way to handle the risk that local conditions represent for future ROI on innovation projects.

Macro institutional theory clearly states abrupt change in local conditions to increase institutional risk that is recognized by PPM theory and neo institutionalism to affect the outcome of innovation projects. An informant from Statoil describes how they perceive local conditions:

It is clear that there are greater challenges in Tanzania than in other countries. This country has just started with exploration of gas. It is a poor country and education is not best in class. In addition, there are only a few persons with vast experience from the oil and gas sector (ST7, 02.05.14).

Informant ST7 emphasizes that local conditions in Tanzania is recognized as a challenge by Statoil. In addition, the government of Tazanias limited experience with petroleum can become a challenge. Figure 11 shows that informants from GE Oil and Gas values local conditions to be the macro institutional factor affecting innovation selection the strongest. In Tanzania local conditions may change with the current revision of of the gas policy (Fouche and Koranyi, 2013), furthermore the upcoming elections in October may lead to unstable and unpredictable local conditions. This instability can cause local conditions with riots, revolts or rebellions, and therefore the next chapter will perform an analysis of how laws and regulations affects the selection of innovation initiatives intended for Tanzania.

7.2.2 Laws and Regulations

The macro institutional theory asserts that laws and regulations, and hereby policy, passed by governments affect how company behave in innovation. Figure 10 presents an overview where more than 60% of the informants value laws and regulations to affect the selection of innovation initiatives within their companies. Accordingly, this is the formal factor with the strongest response from the informants of all macro institutional factors analysed in this thesis. Currently, instability in laws and regulations are a main challenge to conduct gas exploration in Tanzania. The PSA[37] act regulating exploration of natural gas is awaiting a revision and a final decision by the national assembly. The revised legal system for gas exploration will probably not be passed until after the Presidential election in October this year (Zawya, 2014). An employee in the Petroleum Directorate describes the situation in this way:

Tanzania is in a position where they have outdated legislations and they have started a process to develop new rules and regulations. Statoil's PSA will be affected by the current changes, since they have signed an agreement on terms and conditions. How the oil companies behave varies. Some are proactive and interact with the government (OD1, 19.02.14).

[37] The PSA is a Production Sharing Agreement that Statoil has signed with Tanzania's state owned oil company to produce gas offshore of Tanzania's coast.

Informant OD1 emphasizes that laws and regulations are factors strongly affecting how companies selects innovation initiatives. Figure 11 presents results where laws and regulations are also valued to affect the selection of innovations at GE Oil and Gas. If Statoil complies with laws and regulations, this will also affect how GE Oil and Gas considers these factors in Tanzania according to informants GE1 on page 41. Regarding innovation selection, the literature and the empirical research indicate that laws and regulations have a high effect on innovation in the oil and gas sector. An employee at GE Oil and Gas explains in his words how they assess political risk, these also comprising laws and regulations:

> *How much money does GE has to spend, and how much are we expecting in ROI? In reviewing a business case there is an element of institutional risk as well. My job is to review the financial returns and technical feasibility. Institutional risks are considered on another level (GE11, 10.03.14.)*

Informant GE11 indicates that GE Oil and Gas consider institutional factors in their selection principles, but not at his level. This implies that laws and regulations have not been realigned or is not supposed to be considered on all organizational levels. GE1 states that GE Oil and Gas will considers compliance in their innovation initiatives stronger when they are entering a new country if the operator takes a clear stand to comply. The proposition that laws and regulations affect innovation at GE Oil and Gas is confirmed, however they tend to affect the selection of innovation initiatives stronger when the customer is imposed by the authorities to comply with local rules and regulations.

7.2.3 Corruption

Tanzania is ranked number 111 from all countries in the world on the corruption perception index (International, 2014). Corruption is defined as dishonest or fraudulent behaviour conducted by those who have power (Oxford Dictionaries, 2014). The theory on macro institutionalism asserts that existence of corruption affects whether or not companies are willing to engage in investments in a country. In Figure 10, corruption is valued to affect innovation selection. An informant does not describe corruption in Tanzania as critical for operating oil companies:

Oil companies are used to work in countries with more corruption than Tanzania and they have policies in place to limit the risk and exposure. Progress may be slow in many countries and it could be tempting to pay to move the approval process through the system. 10-15 years ago, that might have been the solution, but global and local anti-corruption legislation has emerged. (...) Oil companies have access to decision makers that will understand the importance of swift decisions. The whole supply chain will benefit from this (IN1, 07.02.14).

Informant IN1 suggests that corruption is not a vast risk for ROI to companies in the oil and gas sector in Tanzania. At the same time, the informant indicates that corruption is strongly affecting how oil companies behave in Tanzania. For GE Oil and Gas, corruption has resulted in a number of internal mechanisms suggesting that anti-corruption is important:

We have good training systems for everyone who works at GE: The anticorruption work is certainly included in these systems and there are mechanisms and checkpoints on every level of the business. There is no excuse for noncompliance (GE9, 22.01.14).

Informant GE9 suggests that anticorruption work is a priority everywhere GE Oil and Gas conducts business. According to informant IN1, the sector may benefit from personal connections with the Tanzanian government enhancing swift decisions. In addition, Figure 11 shows that corruption does not affect the selection of innovations strongly. The analysis suggests that this is the case because GE Oil and Gas have efficient routines that take care of anticorruption. Furthermore, high levels of corruption in Tanzania is not affecting how GE Oil and Gas select innovation initiatives.

7.2.4 Agreements and Time

An agreement is a formal institutional factor implemented by the authorities and encompassed in a document regulating how companies behave in Tanzania. Statoil has signed a PSA with the Tanzanian government enabling them to explore and produce natural gas. The gas policy regulating this agreement is currently subject to revisions and this can strongly affect Statoil's final decision to engage in exploration of gas in Tanzania. In addition, and this has been mentioned throughout the chapter – the contents of the agreement may impose requirements on Statoil regarding type of technology taken into use in the project. Accordingly, this factor constitute an institutional risk for GE Oil and Gas on efforts made to deliver technical equipment to this project. A senior employee at INTSOK describes it like this:

In this case, they are exploring gas. When will Statoil and GE initiate the final decision to extract gas? Are there any advantages in the early phases? What happens if the competitors establish an office and we do not? Most suppliers will probably enter the Tanzanian market early and employ a couple of locals to do administrative work and to function as a source to collect information (IN1, 07.02.14).

Informant IN1 indicates that Statoil's decision to stay in Tanzania will affects how suppliers choose to invest their resources in order to win the contract. At the same time none of them can be certain of winning the contract.

The Tanzanian national assembly may use a lot of time to pass the PSA legislation, and this strongly affects Statoil's final decision to engage in exploration of gas. According to the PPM literature, time-consuming decisions sets innovation under higher resource constraints and increases the risks of failing with technology development. Informant IN1 describes this:

Do not forget about time. You have a population who do not see any significant fast benefits. For instance, the ongoing construction of the pipeline in Tanzania has led to demonstrations because the local population wanted to stop the construction. They wanted to keep the gas to themselves, and several local villagers were shot and killed by the military (IN1, 07.02.14).

Informant IN1 gives an example where time can becomes a challenge to gas operations in Tanzania. The informant indicates that the inability of the Tanzanian government and industry to manage rising expectations can lead to severe circumstances posing high institutional risk. Internal compliance programs can be a means to reduce these risks[38], but they demand resources and time to align throughout GE's organization.

The PSA agreement between Statoil and the Tanzanian authorities can affect innovation selection at GE Oil and Gas strongly. Time-consuming decisions regarding laws and regulations passed by this agreement is valued stronger in Figure 10 than in Figure 11 indicating that this is more important for Statoil than GE Oil and Gas. The theoretical proposition that agreements affect innovation selection on a macro institutional level at GE Oil and Gas is confirmed in this paragraph. In this sense, time closely relates to creation of local content that will be discussed in the next section.

[38] These are meionted in chapter 3.3.1.

7.2.5 Creating local content

The creation of local content is emphasized by macro institutional literature, by several informants, by documents and from observations (12.03.14) to reduce risks emerging from institutional factors in areas with high institutional risk. It can be especially useful in a market where the company never have conducted business before. Furthermore, both the macro institutional theory and data gathered from observations and interviews regards the creation of local content to be increasingly important in developing countries, because local conditions are a high risk for innovation. Creating local content can be a method to reduce local opposition to exploration of natural resources, theft and corruption. These problems have arisen from other African countries subject to exploration of oil and gas (Fouche and Koranyi 2013). The macro institutional theory recognize institutional risks to be as a vast challenge when operations are conducted in developing countries since institutions in these countries are often more unpredictable. The main problem of using local content described by a senior associate in INTSOK:

A huge capacity building and training program will be required in the years to come to prepare local enterprises and local labour to participate in the activities. The government in partnership with the oil companies and the education sector will have to look for ways to build industrial competency (...)It will have to become part of the upgrading of the country's education system that will be necessary to provide candidates for future employment (IN1, 07.02.14).

The local authorities impose companies to create local content in Tanzania. At the same time, they can have their own compliance programs to enhance local content when enter a new country. For instance, employing local competency instead of spending resources to hire expats can reduce costs and at the same time reduce institutional risks. Furthermore, Figure 11 indicates that the creation of local content is a priority at GE Oil and Gas and valued to affect the selection of innovation initiatives. Again, informant GE1 on page 41 suggests that one way local content can affect innovation at GE Oil and Gas is by creating a production facility or hiring local people to work on innovation projects. Informant IN1 emphasizes difficulties to create local content in Tanzania since the country lacks knowledge and competency that can be leveraged. Furthermore, he implies that local content will only benefit a few who are hired to work for the oil and gas sector. Of the selection at GE who speaks of macro institutional factors, creating local content is valued higher than the average for all informants. Still, the strong theoretical and empirical emphasis on the creation of local content is not reflected in the interviews. Only 30% of the informants values this to affect innovation selection strongly. A top manager at GE outlines his thoughts on local content:

Regarding local content in Tanzania, it depends on the contract and how much we will have to use. At the end of the day, it depends on how experienced the local expertise is. In Tanzania however, I guess, we would not really use local content (GE17, 11.03.14).

Informant GE17 indicates that GE Oil and Gas will consider local content if they are imposed to do this by formal macro institutional factors. Furthermore, the analysis has disproved the proposition that local content in developing countries strongly affects innovation selection at GE Oil and Gas in Tanzania.

7.2.6 Forums, public perception and communication with local population

Formal institutional factors on a macro level seems to be affecting innovation selection strongly much due to the high risks of conducting business in a developing country. This section will discuss two informal factors to manage the institutional risks emerging from formal institutional factors and one factor, forums, where companies can engage in informal interaction with individuals, companies and authorities.

Institutionalism emphasize communication as a means to affect how individuals or groups of individuals behave. Only a few informants highlighted communication with the local population as an important means to turn the public perception in favour of gas exploration in Tanzania. Informant SI1 could however encounter for open forums to be an effective means to interact with the local population, manage their expectations and to reduce institutional risks. These three macro institutional factors have not been valued to affect innovation selection strongly in Figure 10. The motive could be that these factors affect every phase of the Funnel instead of the selection principles in partidular. Informant ST7 describes some of the methods Statoil applies when they interact with the local population:

When you enter a new country, several components have to be taken into account. These include training and economic support of initiatives and academic courses, educating students and local companies on standards and safety used in the oil and gas industry. Several steps are included in this assessment and they may change over time (ST7, 02.05.14).

Informant ST7 describes several methods that Statoil use to interact with the local population influencing their public perception of gas exploration. According to Figure 11, GE Oil and Gas does not emphasize these factors to affect the selection of innovation initiatives. Consequently, the analysis is not supporting the proposition that Forums, public perception and communication with the local population affect innovation selection strongly. The theory enhances that these factors could be crucial to reduce institutional risk and thereby facilitate radical innovations. However, this seems to be more relevant for Statoil than GE Oil and Gas.

Summary

- The analysis has revealed that the current revision of the national gas policy and the upcoming elections in Tanzania represent vast institutional risk factors with strong effects on innovation selection. These institutional factors may increase instability and institutional unpredictability and can be a decisive factor whether Statoil decides to carry out the operation or not.

- GE Oil and Gas and Statoil are not using vast resources to reduce institutional risks in Tanzania by creating local content, communicating with the local population and managing the public perception. Low expectations of local conditions affecting innovation and implementation of new technology, and strong linkages between the oil and gas industry and the authorities may be reasons why these factors are considered to be unimportant in selection of innovation initatives.

- The analysis suggests that Statoil and GE Oil and Gas could benefit from increased efforts to reduce institutional risks in Tanzania through compliance and the creation of local content. Despite operations offshore or behind a fence, local conditions in Tanzania have led to opposition and violence striking large engineering projects. By increasing the focus on compliance and engaging in communication with the local population, GE Oil and Gas stands in a stronger position to reduce the risk of failing with new technology. Consequently,

8 Gas and Oil Implementing Agreement

The IEA was founded to help industrialized countries coordinate a collective response to major disruptions in oil supply (International Energy Agency, 2014). Together with GE Oil and Gas and four founding countries, the IEA has established the multilateral agreement; The Gas and Oil Technology Implementing Agreement (GOT IA) in 2013. The main objective with the GOT IA is to bring key decision makers and innovators from the government, oil and gas companies, research communities and NGO's under one agreement to share knowledge and competency. The aim is to create a global dialogue to discuss R&D, technology gaps, and operating practices to accelerate innovation and improve the safety, sustainability and public acceptance of hydrocarbon operations (GOT IA, 2014).

The GOT IA is a selection principle reducing risks of failing with radical technology development and execution. Decision makers come together in an informal setting to make policy suggestions and to agree upon technology gaps directing technology development. Each technology gap addresses a task area where an oil company is responsible to foresee the technology development. The agreement aims to develop technologies associated to long-term commitment and inherently lead GE Oil and Gas into a new energy landscape where the focus on reducing CO_2 emissions and costs related to oil and gas exploration is becoming increasingly important. The GOT IA is still in the early stages, with the launching conference in New York back in October 2013 (Karlsen and Doucette, 2013).

This embedded case study was conducted on the second meeting in Florence on the 8th-10th of April 2014. The regulatory framework with the effects this agreement may impose on innovation selection are still unknown and difficult to anticipate, but the founding parties behind the agreement have high ambitions to fill technology gaps in the oil and gas sector (Karlsen and Doucette, 2013). The analysis will use data gathered from observations, interviews under this meeting, presentations, notes taken underway and the rich sources of other data material. GE Oil and Gas believes that addressing the technology gaps through regulatory and policy drivers in a collaborative and open manner can lead to outcomes that support the optimum development and use of hydrocarbon resource (Karlsen and Doucette, 2013). The Norwegian Minister of Trade and Industry emphasized that when the industry cannot compete on costs, the industry has to create new knowledge and develop technology to meet this challenge. In this respect, succeeding with promising innovation initatives with a high potential to succeed is paramount, and the local government has a responsibility to help companies with this objective (Mæland, 2014). The GOT IA is an example of a selection principle that can enable this vision and facilitate radical innovation initatives solving some of the major challenges facing the industry.

8.1 Technology and innovation challenges on the GOT IA

Challenge	Value score
Path Dependency	92,31 %
NIH-syndrome	84,62 %
Lockout	84,62 %
Lock-in	84,62 %
Inertia	84,62 %
Flexibility	7,69 %
Risk-Taking	7,69 %
Experimentation	7,69 %

Figure 12: Innovation challenges considered by informants interviewed in Florence.

Figure 12 presents the general opinion expressed by 13 informants interviewed under the meeting in Florence. The Figure represents a pattern retrieved from these interviews and summarized and visualized into challenges that the emphasized by the informants. The formulation of the interview guide and scarce time may have affected the results in Figure 12[39]. The researcher was only given 5 minutes per interview. The vast majority of these informants were interviewed under the third case study in Florence. Then one can ask the question if this is an opportunity or an obstruction? First of all, these informants indicate a high level of awareness of innovation challenges within the industry. Secondly, it will be interesting to see how they assess the GOT IA and how this will affect innovation selection and in turn the facilitation of radical innovation initiatives.

All five task-areas have identified technology with a potential of resulting in radical transformations and giving the inventor a commercial advantage in the new energy landscape e.g: elimination of gas flaring, unmanned production facilities and novel drilling concepts (Wiencke, 2014). The researcher performed participant observation during this case study and was included on a workshop on clean and safe hydrocarbons. The overall impression of the researcher was an unwillingness to address the technology gaps with radical technology. Instead, a common characteristic remained to address the challenges through incremental improvements to existing technology and by creating informal and formal ties (institutional factors).

[39] The interview guide can be found in the appendix.

8.1.1 Path dependency, Lock-in, Lockout, Inertia and NIH-syndrome

Path dependency transpires from a history of technology development from a longer period. Lock-in appears out of different reinforcing effects and lockout occurs when the costs of changing paths becomes too vast. An informant describes the shift in focus on technology development within the oil and gas sector:

As of today, I have no doubt that our greatest challenge is to bring down our costs, become more efficient and get the same output to a lower price. This challenge involves largely the way we work towards external suppliers and external partners (…) Not many months ago the industry were unaware that costs would have so much importance, and only volume and time were relevant for innovation and technology development (ST1, 17.02.14).

Informant ST1 from Statoil implies that the sector has been locked into a technology path driven by increasingly higher costs and inefficient innovation and technology development. Furthermore, he describes this path to be reinforced when Statoil perform innovation collaboration with suppliers and stakeholders. ST1 comprises the main challenges GOT IA try to address in this technology-sharing platform.

According to the values presented in Figure 12, informants interviewed under the GOT IA meeting in Florence have identified path dependent behavior as a major challenge to innovation selection. One of the objectives with the GOT IA is to develop selection principles to reduce costs on innovation and to open up a new technology path. This informant shares a this view:

My hope is that between these organizations, from all over the world and from different sectors, we will be able to do things that can accelerate R&D spending on technologies that are environmentally important. Furthermore to help drive down costs, spread awareness on technology and best practices that already exist and could and should have a higher adoption rate and a penetration rate (C3L, 09.04.14).

This informant identifies a number of steps where GOT IA can affect technology development in the oil and gas sector. He emphasizes that in the competing technology path, R&D expenditures are used to develop environmental friendly technologies. The oil and gas sector has experienced lockout from this path because reinforcing effects, like innovation collaboration with suppliers and environmental disasters like Macondo, have been driving up the costs and risks. Accordingly, informant C3L is optimistic that GOT IA may enhance technology that can reduce CO_2 emissions and enable entry into the competing technology path.

At the same time, he means that the GOT IA is a selection principle to spread existing technology and not to develop radical innovations with technology from a new technology path. Rather, he emphasizes that GOT IA can be a method to spread the current technology to other companies and actors internationally.

NIH-syndrome and open innovation recognize external knowledge flows from competency outside the core area of expertise to affect innovation selection by enabling the decision maker to identify promising radical innovation initiatives. Another informant shares the argument that GOT IA can affect technology and innovation by increasing awareness of new technology: *«I believe that perhaps the most important thing GOT IA can do is to take existing knowledge, put it together, analyse it and communicate it in a better way» (C3M, 09.04.14).* This informant, like the former, identifies GOT IA as a tool to counter innovation challenges by spreading the word of existing technology. Furthermore, informant C3M seems to believe that GOT IA may affect the selection of incremental innovations instead of facilitating radical innovations.

The researcher experienced while observing the informants and participating in a workshop on clean and safe hydrocarbons, that the main focus in the discussions was not to develop radical innovations by utilizing technology outside the current technology path. The informants seemed to be reluctant to engage in innovation initiatives that could revolutionize the industry and decrease CO_2 emissions and other greenhouse gases to a minimum. On the one hand, the informants identified the sector as extremely path dependent. On the other hand, they expressed a desire to start with implementing current technology and increase their performance through incremental innovation. Inherently, inertia can be a vast innovation challenge to facilitate radical innovations and it is considered a vast innovation challenge in Figure 12.

According to the theory on open innovation, GOT IA has a number of elements to counter the challenges for innovation selection described in Figure 12 and Figure 4. The theory on open innovation considers variation and knowledge sharing to foster the selection of the most viable and promising innovation initiatives and informant C3A describes GOT IA like this:

> *It is a way of sharing what is going on across multiple sectors around the world, so that North Sea operations in Norway can learn about operations based on American experience. Perhaps some technology can be applicable to the North Sea – and vice versa. The Gulf of Mexico may need technology from the North Sea (C3A, 08.04.14).*

Informant C3A emphasizes a pattern: The GOT IA is an excellent tool to spread knowledge and technology on an international scale. It is unique in this sense and may counter path dependent behavior, NIH-syndrome, lock-in and lockout that are vast challenges to the selection of innovations. Furthermore, it may be an important mechanism to enhance the potential of radical innovations in the existing technology landscape[40]. However, there seems to an element in inertia to develop radical innovations based on technology outside the current trajectory. If this challenge can be countered, GOT IA has potential to facilitate the selection of radical innovations solving.

8.1.2 Flexibility, Taking Risk and Experimenting

In the objective of creating GOT lies an ambition of taking risks and experimenting with technology that the industry currently has not been enable to do by itself:

> *GOT is an opportunity to create a strategic vision for technologies by dealing with problems that are a little further down the road than a specific business man today would be able to invest in by himself. Through GOT he or she can take a little bit of risk for a long-term gain (GE16, 08.04.14).*

Informant GE16 adresses GOT as an opportunity to address the major problems striking the conservative and path-dependent oil and gas sector. In addition, informants from Figure 12 values the industry as not especially willing to take risks, experiment or flexible in terms of innovation selection. One informant, however, perceives commercial companies in the oil and gas sector adept at finding technical solutions:

> *Will it continue to be economical profitable, accounting for the associated costs related to climate change, health issues and so on that comes with the production and consumption of hydrocarbons? From a commercial point of view, I do not think there are any high risks because I think the companies will be highly adapt at finding solutions (C3H, 09.04.14).*

Informant C3H emphasizes high costs and risk-aversion as the main challenge facing the industry. In addition, competing energy suppliers may develop technology enabling them to deliver cheaper and cleaner energy. The theoretical framework implies that a balanced innovation portfolio with incremental and radical innovations gives higher ROI. Furthermore,

[40] These are described in chapter 2.1.1.

tight collaboration with stakeholders[41], in addition to interaction with policy makers[42] is emphasized to reduce risk and enable the selection of radical innovations. In addition, the knowledgebase of experts GOT IA can provide experimentation and flexibility. An organization that has succeeded in developing revolutionzing innovations is DARPA[43]. The agreement gathers extremely talented people to collaborate and deliver break-through innovation on a short time scope. A top manager says this about DARPA:

> *GE and Statoil have the possibility to create combined superteams with extremely skilled people trained to collaborate. A problem for these types of collaborations are IP. Therefore you need a bulletproof agreement dealing with all terms and conditions and establish the rules that take of all the hinders innovation collaboration may encounter e.g. ownership (ST4, 06.03.14).*

Informant ST4 implies vast difficulties to implement a DRAPA-like agreement on an inter-organizational level. In he identifies institutional factors as necessary to facilitate the selection of radical innovations. The analysis suggests that if the GOT IA can impose the creation of superteams with the extremely talented people who are already attending. Furthermore by creating rules induces risk-taking, experimentation and flexibility, the GOT IA may have the potential to fulfill its ambitious objectives and develop successful radical innovations.

Summary

- Inertia is a threat to facilitate radical innovations, which is suprising since no other innovation challenges is found in the analysis. Inertia can be overcome through implementing institutional factors opening for variation in knowledge and competencies into GOT IA. One way to achieve variation is to invite organizations from other industies to counter and consequently increase the potentital of selecting successful radical innovations.

- GOT IA has a design that reduces risk and enable experimentation and flexibility. The analysis unveils that these innovation factors are lacking, and that implementing institutional factors based on the DARPA-recipe may be an

[41] According to the literature on open innovation.
[42] According to the literature on institutionalism.
[43] Presented in chapter 3.5.

inducement mechanism to develop radical innovations revolutionzing the industry.

8.2 Macro institutional analysis: Vast challenges and major opportunities

The innovation analysis indicates that GOT IA has reasonable good chances to facilitate radical innovations. Developing new policy implications are a main objective with the GOT IA, and institutional factors are closely intertwined with inertia – the main innovation challenge to innovation selection. Policy makers, governments and makers of international standards participates on the agreement implying that GOT IA has the potential to use macro institutional factors to induce innovations in the oil and gas sector. GE Oil and Gas as the operating agent behind the agreement, stands in an ideal position if they can use this to their advantage; Creating innovations that meet institutional requirements, solve commercial problems and influence key decision makers in all parts of the supply chain. Figure 13 present an overview where informants on the third case study value macro institutional to strongly affect innovation selection. Formal institutional factors, regulations and laws have been valued the highest. Therefore the analysis starts with these factors.

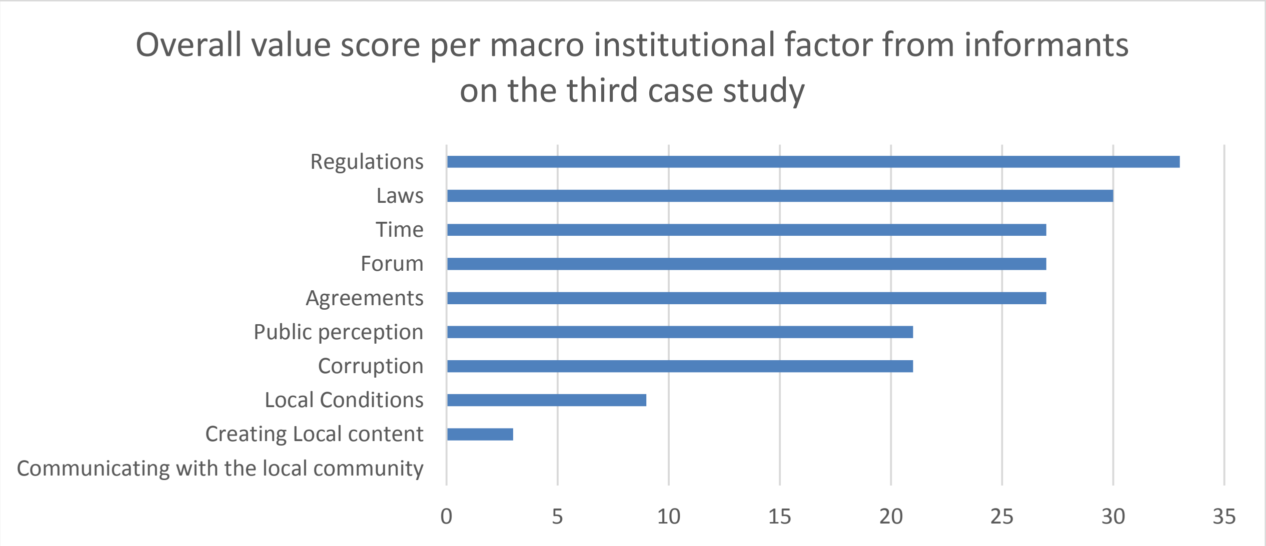

Figure 13: Overall value score per macro institutional factor from informants on the third case study.

8.2.1 Regulations, Laws, Agreements and Forums

Macro institutionalism presented in chapter 3.3.1 says that institutional factors can affect innovation selection in commercial companies because they outline regulations in the favor of some companies and to the disadvantage for others. GOT IA is a formal agreement where some organizations sign a document and undertakes specific responsibilities related to innovation and technology development. It is also an informal forum where policy makers and those companies who have to comply with these regulations can meet and discuss how they can collaborate to develop innovation initiatives dealing with the global energy challenges facing the world. Informant C3G describes the global challenges:

> *The Gas and Oil Technology Initiative is a collaborative dialogue vehicle involving policymakers, governments, companies and research organizations who operates around the world. (...) The GOT collaboration addresses collective ways to accelerate technology that needs to be developed to meet the huge growth in global energy demand ahead and which at the same time enables oil and gas to be a part of a long term sustainable energy future (C3G, 08.04.14).*

One of the main objectives with the GOT IA is to contribute to a technology gap and addressing this through radical innovation initiatives can be an opportunity. Furthermore, the informal tie GOT IA creates may benefit the attendees, since they can address laws and regulations in the best interest of their own technology development and innovation. For GE Oil and Gas, who is the operating agent, the theory on institutionalism distincintly indicates that GOT IA can provide significant benefits. GE Oil and Gas can use the forum to interact with policy makers. potential customers and influence how the industry develop technology in a long-term perspective. Furthermore, as an operating agent they can redeem information inaccessible from competitors which could give them increased knowledge and a competitive advantage in the selection of innovations. GOT IA is still in the premature days, but if the forum manages to realize its potential GE Oil and Gas has a unique opportunity to reduce institutional risks, benefit from direct interaction with kay stake holders facilitating the selection of successful radical innovations.

Figure 13 presents an overview where informants from this case study values formal factors, laws and regulations, to strongly affect the selection of innovation initiatives in their respective companies. The Figure supports data presented in Figure 10 where laws and regulations are valued to strongly affect innovation selection. However, a discrepancy can be found in the relationship of how agreements and informal forums affect innovation selection.

Informants interviewed on this case study value forums and agreements as more important to innovation selection than the average presented in Figure 10. The reason may be that GOT IA itself is an informal forum and a formal agreement and that informants may have a stronger incentive to value this as an important tie since they are already attending.

The agreement is an opportunity to use a collective approach for the creation of policy implications enhancing technology development associated to high risk. Furthermore, GOT IA can build a new direction for technology development aiming to consider high costs to new technology development, reducing risks to invest in sustainable solutions improving the position of fossil fuels in the future energy landscape on a long-term.

On the one hand, GOT IA can be used to make new policy implications. On the other hand, GOT IA can also be a forum to discuss existing policies, because policies may also hinder companies to engage in innovation. A top manager from API expresses his view to how GOT IA will affect technology and innovation in the industry:

> *Well, the major challenge we face across the board is access to resources. Regulations that can severely change our business base, and you know, some of the other ones such are tax issues. Everyone wants to tax the industry – even though there is no real good case for it (C3I, 09.04.14).*

Informant C3I addresses that public regulations can severely change how companies in the oil and gas industry conducts business, and he asserts that tax regulations and concessions can severely affect the ability a company has to pool resources into innovation. Resource constraints is identified as a major challenge to innovation selection in the PPM literature, consequently GOT IA can reduce risks of innovation and technology development. Furthermore, the citation from informant C3I supports the theoretical proposition that laws and regulations may be an obstacle to innovation. He enhances that tax regulations affects innovation strongly, and perhaps this is an incentive that could be discussed to enable the selection of radical innovation initiatives. The proposition that these macro institutional factors affect innovation selection is confirmed, but the future direction of the GOT IA decide to what extent they will affect innovation selection.

8.2.2 Time

Time is valued to strongly affect how companies select innovation initiatives in Figure 13. Throughout the thesis, time has turned up as a challenge for innovation and technology development. GOT IA is identified as selection principle that can reduce the risks this institutional factor may have on innovation selection. A top manager explains how he sees the GOT IA in terms of time perspective:

I think collaboration can affect how the large companies and organizations consider the future opportunities and possibilities to use innovation more efficiently in a longer perspective. I think this can enhance R&D efforts in the industry in a longer perspective (C3J, 09.04.14).

Informant C3J identifies GOT IA as a principle tool addressing the focus upon technology development and innovation in a longer perspective. It is acknowledged that it can be inherently difficult to succeed with radical innovation when this is based upon technology from a competing technology path, since it usually require a long-term commitment. From the value score time received in Figure 13, it can be deduced that the companies who attended the meeting in Florence are aware of these difficulties. Consequently, time is a factor that has a strong effect on innovation selection – and the GOT IA is a selection principle that can use its benefit of addressing long-term perspectives as a reason for facilitating radical innovations.

8.2.3 Corruption and Public Perception

Public perception and corruption are informal macro institutional factors that directly affects the behavior of policy makers and decision makers in companies. How the public perceives the use of hydrocarbon resources is one of the main challenges facing the oil and gas industry. Furthermore, public awareness oil spills and greenhouse gas emissions may increase resistance towards non-renewable sources of energy supply. Public perception is only to some extent enhanced in Figure 13 to affect the selection of innovation initiatives. The technologies sought to be developed on the GOT IA can involve initiatives with the potential to reduce environmental issues related to oil and gas exploration. Radical technologies may change the public perception in favour of fossil fuels, and therefore this factor affects the selection of innovation initatives.

Corruption is an informal factor that may have major implications for the outcome of future ROI on innovations. Major global concessions and or incentives in respect to the implementation of new "green" energy sources and the restrictions that may be imposed upon the Oil & Gas Industry, enormous pressure may be placed upon political persons in influential positions in the decision making process. This creates a situation where the financial stakes and potential loss or benefits are so great, that corruption may be used to influence politicians and government officials. Corruption is not emphasized to strongly affect innovation initatives in Figure 13. The reason may be that corruption is more common in developing countries where the normal level of earnings in that country increases the temptation for corruption in positions of authority (Shleifer and Vishny, 1993). Currently, participants in the GOT IA come from governments, organizations and firms from emerging economies or developed countries. Therefore, corruption is not on the agenda. However this factor may increase its influence on innovation in the future.

8.2.4 Local Conditions, Creating Local Content and Communicating with the local community

Local conditions, creation of local content and communication with the local community have received a low value score in Figure 13. Furthermore, these macro institutional factors were not emphasized in the agreement. In addition, only a few informants mentioned these factors as the major challenges facing the industry. GOT IA is directed towards oil and gas producing companies. The founding countries behind the agreement are industrialized countries, and perhaps these factors would be on the agenda if countries with high institutional risk were involved in the agreement as well.

Summary

- The GOT IA is an informal forum and a formal agreement to discuss macro institutional factors and perform technology collaboration. By involving more participant countries it can gain recognition in order to become a global platform for technology sharing. Furthermore, this is important to deal with the institutional factors, corruption, public perception and local content, which is not targeted by the agreement today.

- The GOT IA has the ability to address long-term challenges with policy implictions towards law-makers. Laws and regulations affect how companies select innovation initatives. By addressing policy facilitating radical innovations aimed at reducing costs and enhacing clean and safe operations, GE Oil and Gas can increase the potential of succeeding with radical innovations.

9 Concluding chapter

This thesis has analyzed how innovation factors (challenges and opportunities) and institutional factors affect the selection of innovation initiatives. The thesis proposes that institutional factors, formal and informal, strongly affect the selection of innovation initiatives in three embedded case studies. A three level qualitative analysis, intra-organizational, inter-organizational and macro-institutional, of how institutional factors have affected the selection of innovations have been conducted through interviews, observations and documents.

This case study has investigated how GE Oil and Gas collaborates with customers and stakeholders. By doing so, the study has strived to understand how GE Oil and Gas can facilitate the selection of radical innovations. The theoretical framework explored the selection of radical innovations with a high risk of failure and argued that increased knowledge on institutional factors and innovation could reduce risk and facilitate successful radical innovations. A radical innovation leads to significant changes in the sector, and a main objective has been to investigate how technology can solve major challenges facing the oil and gas industry. By developing cost effective and environmental-friendly solutions, GE Oil and Gas can increase commercial viability and gain a competitive advantage on other suppliers.

1. **What affects the selection of innovation initiatives at GE Oil and Gas, and how can these selection principles facilitate radical innovations?**

The analysis of innovation factors indicates that GE Oil and Gas holds the opportunity to select and succeed with radical innovation initiatives. Compared to external partners analysed in this thesis, the company is willing to take risks and experiment with new technology. Furthermore, the analysis reveals that GE Oil and Gas is less path dependent and more open to change, both of which are prerequisites for the selection of radical innovation initiatives. However, the company faces a few innovation challenges that may indicate why GE Oil and Gas has been unsuccessful in introducing radical innovations.

Internally, the focus of acquiring technology companies transpiring from path dependency has created challenges to innovation collaboration. The newly acquired companies have been reluctant to share their technologies and have resisted the selection principles GE Oil and Gas use to select innovation initiatives. Furthermore, the analysis reveals that the Macondo accident has increased inertia in the oil and gas sector, and reinforcing a lockout-effect to experiment with technology from competing paths. In addition, this has created a lock-in effect where the risk of failure and high costs is seen as a hinder to succeed with the selection of radical innovations. Finally, the lack of flexibility and rigid structure of the selection principles GE Oil and Gas use to consider innovation initiatives is a challenge to select radical innovation initiatives. The analysis concludes that these innovation challenges alone are not the hinder for the selection of radical innovations at GE Oil and Gas. The analysis proposes that formal and informal institutional factors strongly affect how GE Oil and Gas selects innovation initiatives and use this as a starting point for a three level institutional analysis.

Proposition: Institutional Factors will strongly affect the selection of innovations in GE Oil and Gas

The analysis implicates that the selection principles GE Oil and Gas applies, enable dynamic technology discussions based on trust and open communication within GE, between GE and the external partner and between GE and organizations on a government level. Consequently, informal institutional factors on all three levels affect the selection of innovations and create ties that induces the selection of radical innovations. However, despite these implications, GE Oil and Gas encounters major obstacles to successfully implement and succeed with innovation initiatives.

On the intra-organizational level the main obstacle to facilitate the selection of radical innovations are insufficient formal routines for cross-sectional innovation collaboration. GE stands in a unique position to access several types of technologies from their internal research centers and utilize competency from a wide array of intra-organizational business to innovation projects. However, obstacles arise when employees aims to engage in cross-sectional collaboration. In-effective and complicated routines delay innovation projects. In addition, each business unit has their own profit and loss budget excluding innovations running across several business units. The analysis reveals that innovation projects tend to become under-prioritized despite top-management support. Furthermore, insufficient formal routines to facilitate effective cross-sectional collaboration is the biggest bottleneck to facilitate radical innovations.

Lengthy negotiations on terms and conditions with customers and stringent selection principles are the greatest impediments to the selection of innovation initiatives on the inter-organizational level. If GE Oil and Gas can leverage from the informal relationships with external partners and spend more resources to receive the customer’s approval to qualify new technology, the selection principles could facilitate radical innovations with a high potential to succeed. Furthermore, formalizing the business case into a selection principle would increase recognition of innovation initiatives and aligning interests from both companies to succeed with radical innovations. In addition, this could help drive radical innovations through the internal organization at both companies.

The macro-level analysis reveals that local conditions in a country can affect the selection of innovations at GE Oil and Gas. Furthermore, the analysis reveals that as a supplier, GE Oil and Gas would prioritize the creation of local content when this is a requirement from the customer. However, when going into a developing country, GE Oil and Gas does not spend vast resources to counter the high risks of failure unstable and unpredictable institutional factors constitute for innovations. The analysis implies that increased attention to create compliance programs and a closer interaction with the local population can ease the introduction of innovation initiatives aimed at new countries. Laws and regulations affect the selection of innovations at GE Oil and Gas strongly. Policies can reduce risk of failure or create obstacles directly affecting the facilitation of radical innovations. The analysis reveals that a collective approach between commercial organizations, NGO’s and governments seem to be a viable approach to develop radical innovations with a potential to solve the major challenges facing the oil and gas industry. Consequently, innovation factors and institutional factors strongly affect the selection of innovation initiatives at GE Oil and Gas. Furthermore, they are closely intertwined, and improvements to formal institutional factors seems counter innovation challenges and increase opportunities to facilitate radical innovation selection at GE Oil and Gas.

2. How can GE Oil and Gas increase the potential to succeed with radical innovations?

The analysis implicates that formal institutional factors on all three levels strongly affect the potential to succeed with radical innovation initiatives at GE Oil and Gas. The analysis reveals that companies who fails to succeed with radical innovation initiatives at times where innovation factors are not the main challenge to innovation selection, can facilitate successful radical innovations by improving their formal selection principles. Improvement occurs by strengthening formal principles through the allocation of resources (time, personnel and money), removing time-consuming bottlenecks for innovation and setting the priorities to select and succeed with radical innovations. Creating a selection principle enhancing commercial interests of involved parties into a separate Funnel for radical ideas was suggested to increase the potential of radical ideas at GE Oil and Gas. Finally, the thesis implicates that implementing these measures will enhance the unique position of GE Oil and Gas to develop radical technology solving some of the challenges facing the oil and gas industry.

9.2 Limitations and implications for further research

This case study is limited since the institutional factors were analyzed separately and then combined into a three level analysis from three embedded case studies. Going into detail on all three embedded case studies would have strengthened the implications. Furthermore, examining the implications to how GE Oil and Gas could increase its potential by implementing improvements suggested in the previous chapter could have been interesting for further research.

I deliberately chose to limit the institutional analysis on each embedded case study in order to gain insights and data on all three levels. A master thesis has tight time scope and limited space. Therefore, it was considered to be out of the scope of this thesis to perform an in-depth three level analysis on each embedded case study.

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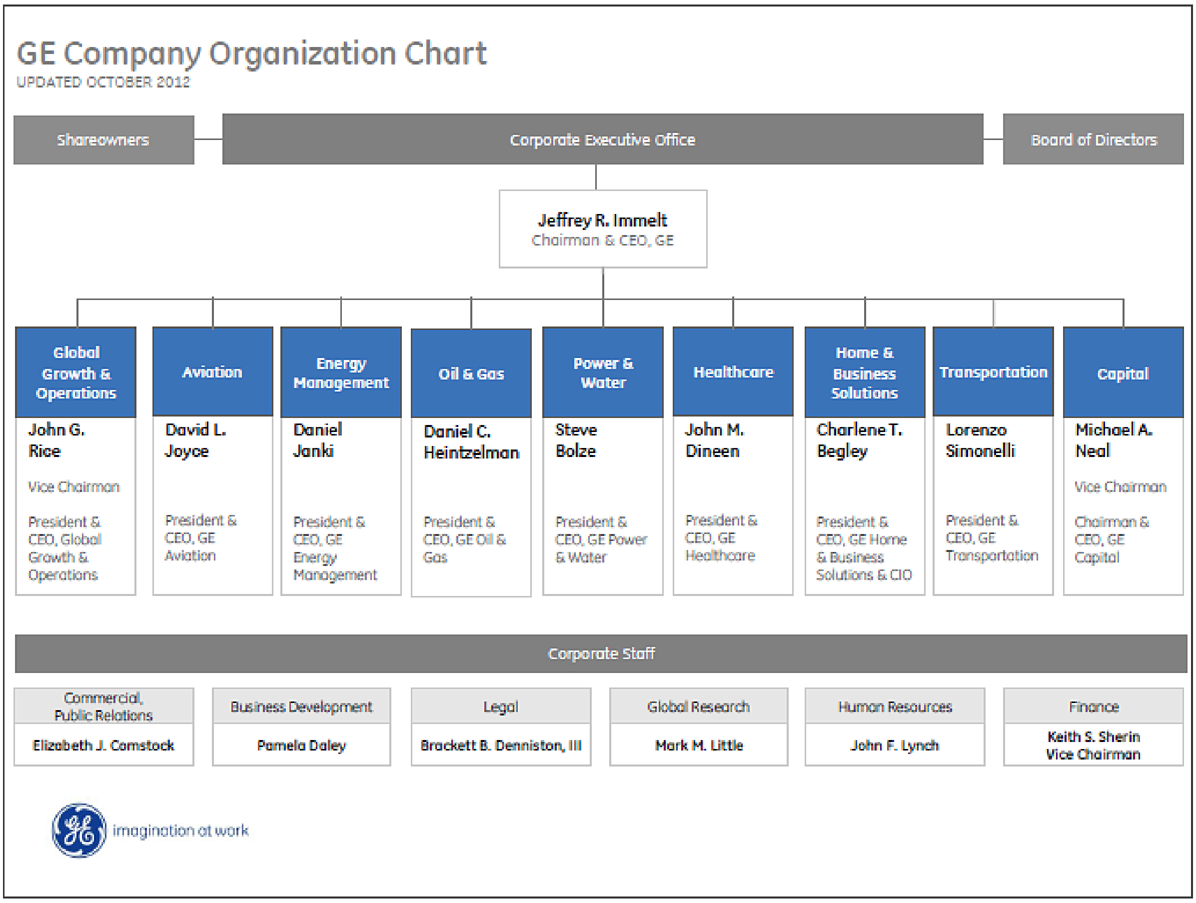
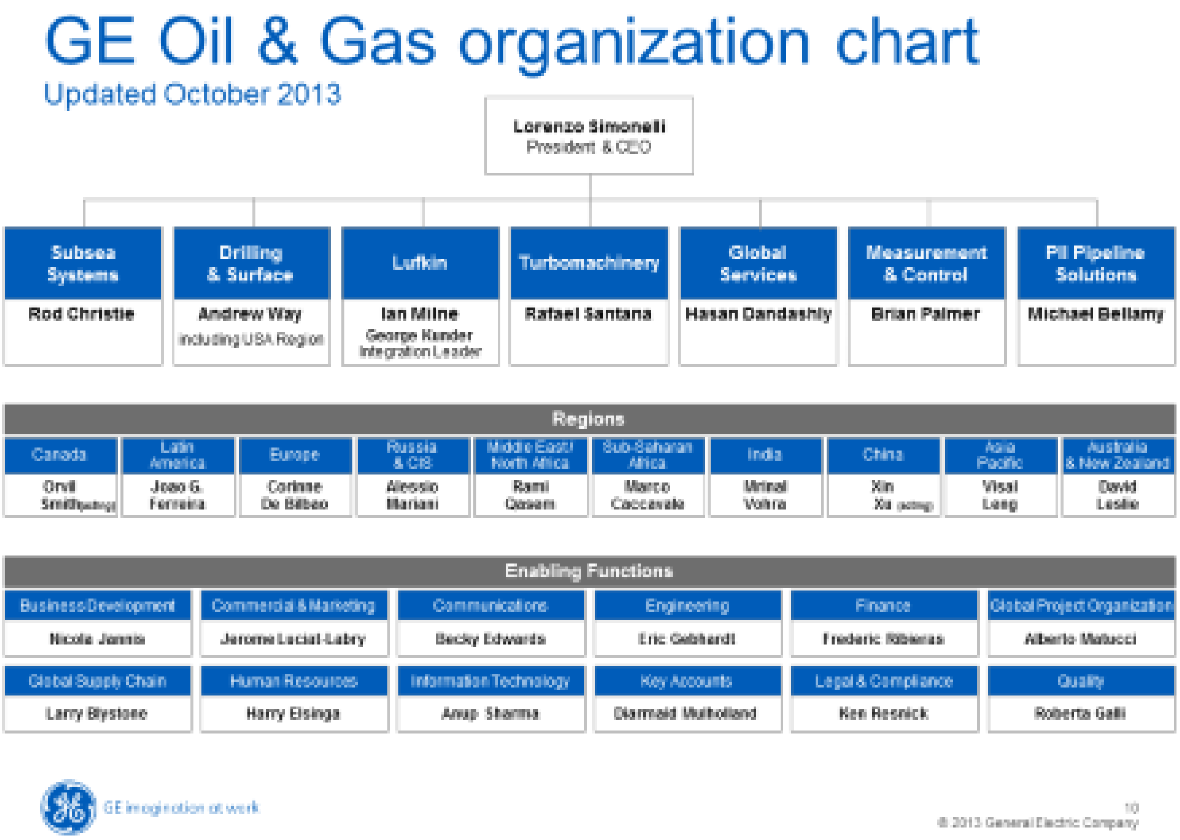


GE corporate organization chart from 2012 (Smartdraw no date).

Level	Development stage	Description
TRL 0	Unproven Idea	Paper Concept. No analysis or testing has been performed
TRL 1	Analytically Proven Concept	Functionality proven by analysis , reference to common features of existing technology or testing on individual subcomponents /subsystems. The concept may not meet all of the technical requirements at this level, but demonstrates the basic functionality with promise to meet all the requirements with additional testing.
TRL 2	Physically Proven Concept	Concept design or novel features of design validated by model or small scale testing in laboratory environment. The system validates that it can function in a "realistic" environment with the key environmental parameters simulated.
TRL 3	Prototype Tested	Full scale prototype built and put through product qualification test program. The prototype is tested in a robust designed development test program over a limited range of operating conditions to demonstrate is functionality
TRL 4	Environment Tested	Full scale prototype (or production unit) built and put through a qualification test program in (simulated or actual) intended environment
TRL 5	System Integration Tested	Full scale prototype (or production unit) built and integrated into intended operating system with full interface and functionality tests
TRL 6	System Installed	Full scale prototype (or production unit) built and integrated into intended operating system with full interface and functionality test program in intended environment. The technology has successfully operated < 10% of its expected life.
TRL 7	Proven Technology	Production unit integrated into intended operating system. The technology has successfully operated with acceptable performance and reliability for > 10% of its specified life.

Table 2.2 Technology Readiness Level

TRL scale.



GE Oil and Gas organization chart.

Date	Problem	Decision	Approach	Consequence
September 2013	Lack of knowledge regarding innovation selection in commercial firms.	Conduct an internet survey to increase insights to innovation selection in commercial firms.	Call large firms who perform innovation or R&D in Norway and ask if they can answer the internet survey.	17 firms completed an internet survey with 18 questions.
October 2013	Identify empirical objects relevant for a case-study	Wanted to include 4 firms from various sectors to do a comparative case study.	Use the Internet Survey and the personal network to approach firms.	Visited 4 firms including GE Oil and Gas .
October 2013	Agreed on an engagement to conduct a case study on GE Oil and Gas and therefore I had to change the research strategy.	Modify research questions and theoretical chapter to a single case design with three embedded units.	I performed an extencive literature review to elaborate on the new topic and engaged in document analysis to increase my contextual understanding.	I was behind schedule compared to the original strategy.
December 2013	Accessing informants	Use the interview as the main source of data and key informants for help regarding interview design and access to interview objects.	Snow-balling and Criterion-Sampling	25 informants were interviewed on the first two case studies. The high number of informants enhanced validity. Help from key informants with interview design improved reliability.
December/January	Time to write methodology chapter before engaging in data collection.	Write draft and complete the chapter as soon as possible since the methods was critical to learn before untaking research.	First draft finished in January. Completed the chapter in February.	Enhanced the quality of my thesis regarding validity and reliability.
January 2014	Data Collection Strategy	Ask for signed consent, record all interviews and then transcribe the data material. Complement the strategy with documentation and observation.	The first interview was conducted in the end of January and the last interview was conducted on the 2nd of May. Observations were conducted on occasions in between the interviews.	Time consuming, but extremely useful and eased coding of data.
April 2014	Data Collection Stategy on the third case study with a short time scope.	Perform participant observation and short interviews.	Participants were informed about my presence. Initatied interviews myself.	13 interviews, document material and observations of informants in their natural environment. Triangulation enhanced quality.
April 2014	Coding of Data on a tight time scope	Stay put to the original strategy despite little time.	Read-through - coloring - awarding points and identifying patterns and trends.	47 Codes
April 2014	Data Analysis and Visualization on a short time scope and lack of pages in my thesis.	Conduct a limited institutional analysis, but complete an innovation analysis across all three case-studies.	Started with the TCA, then Tanzania and the GOT IA	Managed to finish in time, but I wa sunable to conduct a three level institutional analysis on all three case-studies.

Audit diary.

Interview Guide 1

On external institutional and cultural risk:

Can you please tell me about your current position in GE?

- Prompt: How is your work related to risk management on innovation projects?
  1. How does GE Oil and Gas (or Statoil) adapt when you enter a new geographical market? Do you lean on experience from the GE Corporation?
  2. Do you think there are parts of GE that has technology more relevant for this project?
- Prompt: Do you think you will take advantage of experience or knowledge from business areas or departments of GE in this particular project?
  3. What do you think are the biggest challenges for receiving ROI on technical exploration projects in Tanzania?
- Then show the informant the country profile, explain the results and ask for comments.
  4. Do you take these challenges into account when you select innovation projects? How important would you say that these challenges are on ROI for technical exploration projects?
- Prompt: Do you include this perspective into your risk assessments for technical exploration projects?

5. In general, do you think that oil and gas companies have learned from their experience with similar challenges in Nigeria?

- Prompt: What steps have do you mean have been taken to meet these environmental and cultural challenges in Tanzania?

Interview guide 2

On collaboration activities with GE Oil and Gas.

1. Could you please tell me about your current position at Statoil?

- Prompt: Can you elaborate on your responsibilities towards GE Oil and Gas please?

2. What parts of the customer relationship between GE Oil and Gas and Statoil is working well from your point of view? Why do you think that is?

- Prompt: On what areas do you see room for improvement?

3. How often do you interact with GE Oil and Gas through emails, meetings or phone calls?

- Prompt: Do you find it easy to communicate with GE Oil and Gas employees?

4. What does Statoil expect from an international company like GE Oil and Gas?

- Could you elaborate on what you relate to the concept a “One GE”?

5. Do you have agreements with Statoil that facilitate an increased number of technically radical innovation projects?

6. Do GE and Statoil engage in types of collaboration where other companies or organizations participate?

7. When would you choose a cheaper technical solution with proven technology that has never been used commercially before a current, but more expensive, solution?

8. Do you think that technically radical innovation projects will be developed?

- Prompt: Are you under the impression that Statoil require technical radical solutions in the sense that they can solve challenges where existing solutions are insufficient?

9. Are you under the impression that Statoil is open to new technical solutions suggested by GE?

- Prompt: Does this differ from other customers? Why do you think that is?

Interview guide 3

TCA specific questions:

1.What is the aim of the current TCA?

2.One of the goals of the TCA is to create "new solutions" and to "move mountains". From your point of view, how can the next TCA facilitate successful radical innovation projects?

3.What is your opinion on introducing new ideas to the TCA if the idea is based on technology **from other business areas in GE**?

- Prompt: What are the **main challenges** for introducing new technology to the TCA? (Note to self: Not Invented here syndrome, Path Dependency, Lock-In, Resistance to change)

4. Do you think the TCA opens up for the selection of innovation projects associated to high risk?

- Prompt: Compared to how you work with innovation on a regular basis: Do you think the TCA encourage experimentation?

5. What kind of routines do you have for collaboration between Statoil and GE Oil and Gas?

- Prompt: Does the TCA have any special routines that differ from the overall collaboration activities?

6. On which areas do you see room for improvement on the TCA between Statoil and GE Oil and Gas?

Interview guide 4

On internal institutional and cultural factors in GE Oil and Gas

1. Please tell me about your current position at GE.

Prompt: For how long have you been working here?

2. What type of training did you receive when you started working at GE?

Prompt: Did you have the opportunity courses and training on areas outside your expertise or competency since you started working here

3. How does the bonus system at GE work regarding risk? From your point of view, would this encourage risk-taking and experimentation regarding the type of innovation projects you would be prone to select?
4. Do you think employees at GE exploit the potential of technology developed at GRC when they work with innovation projects?
5. How does communication between GRC and GE occur?

Prompt: What areas would you say are working well? What areas would you say need room for improvement? How do you think this can be achieved?

6. From your point of view, as an employee at GE Oil and Gas, do you have the flexibility to experiment with radical technology?

Prompt: Do you have clear routines on where you can find cooperation partners?

Prompt: Would you say that risk-taking on innovation projects differ regardless of type of innovation projects developed?

7. What is your impression on communication procedures across different business areas when working on an innovation project?

Prompt: What areas would you say are working well? What areas would you say need room for improvement? How do you think this can be achieved?

8. When undertaking innovation projects, do you fell that GE has clear routines for cooperation across business areas. How do you develop new ideas across business areas within GE?
9. Prompt: Would you say that cooperation across business areas encourages or discourages radical innovation projects? Please elaborate.

Interview guide 5

Name:

1. Position and organization:
2. Why have your organization committed itself to the GOT IA?
3. From your point of view, what are the major challenges that the
4. In what way do you think the GOTIA will affect innovation and technology development within the oil and gas sector?
5. Do you think the agreement also deals with long-term challenges?

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